The Sources of Innovation and Creativity
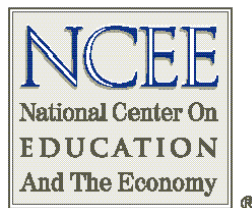
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Introduction

The following pages represent a comprehensive summary of current research and theory on the sources of innovation and creativity, both in individuals and organizations. Based on the recurring concepts in the existing literature, the paper concludes with some recommendations for how education systems can best foster these attributes in students. Both research and recommendations have been conducted with a view to informing US workforce development efforts within the context of the new global economy. The following key questions are discussed:

- What do we know about the sources of creativity and innovation in individuals?

- What do we know about curricula and pedagogical techniques that have proven effective in promoting innovation and creativity through formal and informal education?

- What do we know about techniques that have been proven to stimulate creativity and innovation in the work place?

- What is it about the nature of our culture, our society and our economy that makes our country more creative and innovative than others?

- What contributes to the development of successful entrepreneurs?

- What actions should the US education system take to promote innovation and creativity among students?

- What are some suggestions for further research?

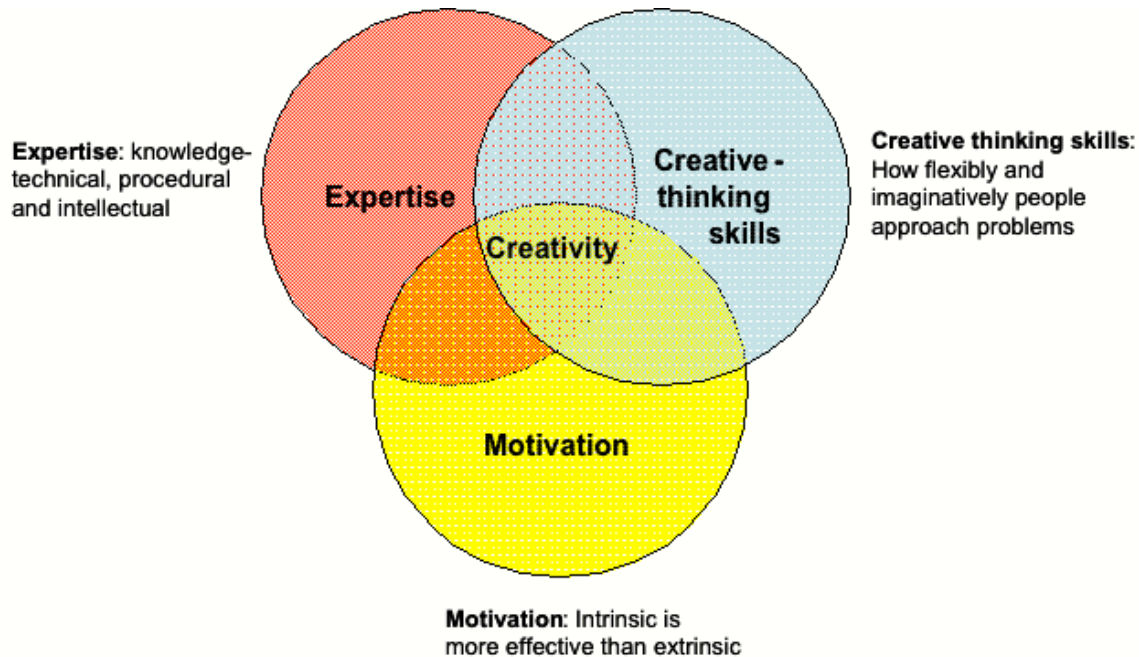## What Are the Sources of Creativity and Innovation in Individuals?

A variety of theorists, using case studies, experiments and a variety of research methods, have attempted to better understand the sources of creativity and innovation in individuals. While these efforts have contributed significantly to broadening our comprehension of the subject, there is nonetheless disagreement between theorists and many hypotheses that remain to be fully substantiated. The challenge lies partially in the nature and definition of creativity itself. Broad, complex and multi-faceted, creativity can take many forms and can be found within a variety of contexts. It is embodied by individuals with a broad range of personal characteristics and backgrounds. It appears that the only rule is that there are no hard and fast rules concerning the sources of creativity. As such, the following paragraphs synthesize the current viewpoints, with the caveat that our understanding of the topic is still a work in progress.

Cognitive psychology provides the most prolific and developed perspective on the sources of individual creativity. In 1950, J.P. Guilford, then President of the American Psychological Association, stated in his presidential address that the topic of creativity deserved greater attention. Following this seminal call to action, psychological research on creativity expanded significantly. These efforts have concentrated on the cognitive processes behind creativity, the characteristics of creative people, the development of creativity across the individual life span, and the social environments most conducive to creativity (Simonton, p. 1).

Teresa Amabile, PhD in Psychology and Head of the Entrepreneurial Management Unit at the Harvard Business School, has provided the field with one of the most simple and yet comprehensive frameworks for the topic. As depicted in the diagram below, creativity arises through the confluence of the following three components:

- **Knowledge**: All the relevant understanding an individual brings to bear on a creative effort.
- **Creative Thinking:** Relates to how people approach problems and depends on personality and thinking/working style.
- **Motivation:** Motivation is generally accepted as key to creative production, and the most important motivators are intrinsic passion and interest in the work itself.

Three Components of Creativity

Expertise: knowledge-technical, procedural and intellectual

Expertise

Creative - thinking skills

Creative thinking skills: How flexibly and imaginatively people approach problems

Creativity

Motivation

Motivation: Intrinsic is more effective than extrinsic

Multiple experts provide frameworks and hypotheses on the sources of creativity yet, it appears that the vast majority of their important contributions to the theory can be categorized as falling within Amabile's three intersecting circles above. Thus, this section of the paper will make use of Amabile's framework as the organizing principle, within which other theorists' viewpoints are categorized.

Knowledge

Amabile describes knowledge as all the relevant information that an individual brings to bear on a problem. Howard Gardner goes deeper into the topic and explains that there are two types of knowledge that may be required for creativity. On one hand, in-depth experience and long-term focus in one specific area allows people to build the technical expertise that can serve as a foundation, or playground for creativity within a domain. At the same time, creativity rests on the ability to combine previously disparate elements in new ways, which implies a need for a broader focus and varied interests. Thus, perhaps the best profile for creativity is the T-shaped mind, with a breadth of understanding across multiple disciplines and one or two areas of in-depth expertise. Indeed, this is what Frans Johansson recommends in his book**, The Medici Effect**. He explains that "we must strike a balance between depth and breadth of knowledge in order to maximize our creative potential," (Johansson, p. 104). He suggests that one way to

improve breadth is to team up with people with different knowledge bases. The educational implications of this recommendation are perhaps in the realm of greater focus on interdisciplinary study and having students collaborate on group projects with team members of varied interests.

Dean Keith Simonton, professor of Psychology at UC Davis, has conducted historiometric studies of great creators. Using a large sample size of successfully creative individuals, historiometric studies quantify the otherwise qualitative characteristics of test cases (their developmental, differential and social backgrounds, for example) and through analysis of the data, attempt to derive some general laws or theories regarding the sources of creativity. Simonton's research supports the idea that individuals must develop in-depth domain expertise to be creative. He explains that we can conclude with great confidence that creative output is linked to the amount of time a person is actively engaged in a creative domain. The relationship tends to be a curvilinear, inverted backwards J function of career age. In other words, creativity production increases with years in the field until reaching a maximum at which point it begins to taper off. Howard Gardner's research into the sources of creativity supports this idea and further extends it to a "ten-year rule": ten years is the approximate time required to build the domain knowledge and expertise needed to spur creative successes. Many creative individuals seem to have breakthroughs in ten year intervals.

Creative Thinking

While both Amabile and Gardner assert that thinking is a key aspect of the creative process, they address this topic at a high level. Amabile suggests that key aspects of creative thinking are:
- Comfort in disagreeing with others and trying solutions that depart from the status quo.
- Combining knowledge from previously disparate fields.
- Ability to persevere through difficult problems and dry spells.
- Ability to step away from an effort and return later with a fresh perspective ("incubation").

Other theorists have addressed the topic of cognitive function from multiple angles. Sternberg's article, "*Creativity and Intelligence*" in the **Handbook of Creativity**, provides an overview of the multitude of theories that have been proposed concerning the relationship between creativity and intelligence. While there is no consensus on the subject, multiple theories provide insight.

Ultimately, Sternberg promotes a "triarchic theory", asserting that there are three main aspects of intelligence that are key for creativity – synthetic, analytical and practical:

1) **Synthetic (creative)**: the ability to generate ideas that are novel, high quality and task appropriate. One aspect of this is the ability to redefine problems effectively and to think insightfully. Sternberg also notes that the basis for insightful thinking involves knowledge acquisition in three forms:

    a) selective encoding: distinguishing relevant from irrelevant information.

    b) selective combination: combining bits of relevant information in novel ways.

    c) selective comparison: relating new information to old information in novel ways.

2) **Analytical**: Critical/analytical thinking is involved in creativity as the ability to judge the value of one's own ideas, to evaluate their strengths and weaknesses and suggest ways to improve them.

3) **Practical**: Ability to apply intellectual skills in everyday contexts and to "sell" creative ideas.

In his article, "*Creative Thinking in the Classroom*" Sternberg stresses the importance of these three types of thinking to overall to intellectual functioning and successful intelligence. The analytic and practical are separate from and support the synthetic. Studies indicate that when students were taught in a way that emphasized all three abilities, they significantly outperformed students taught in a way that emphasized only analytical abilities. The holistic approach also increased performance on strictly analytical, memory-related questions.

Sternberg also explains, "Because the analytical, synthetic and practical aspects of abilities are only weakly related, students who are adept in one of these areas might not benefit particularly from instruction aimed at another area, and in particular, creative students might not benefit particularly well from instruction as it is given in the schools, which typically emphasizes memory and analytical abilities." In an experiment, they found that "high school students who were taught in a way that better matched their own pattern of abilities…tended to achieve at higher levels than students who were taught in a way that more poorly matched their pattern of abilities," (Sternberg, *Handbook of Creativity*, p. 256).

The cognitive processes suggested within Sternberg's synthetic thinking category appear and reappear within the literature. Although a range of vocabulary is used to describe the phenomena, it is clear that the central, agreed-upon component of creative thinking is the ability to combine existing elements of knowledge or understanding in new ways. Simonton's research on the concept of creative Darwinism also provides insight into this aspect of the creative thinking processes. Creative Darwinism asserts that creativity is a stochastic combinatorial process under which multiple ideational variations emerge in an individual's mind, and then a subset of them are selected for preservation and execution. This concept was first put forward in 1960 by David Campbell, an evolutionary epistemologist. Simonton believes that Campbell's model "still provides the best framework for a comprehensive theory of creativity," (Simonton, p. 310). The concept asserts that creativity requires the capacity to generate blind variations in the same sense that genes might generate random mutations and that this generation is not linked to the probability of success of any given variation. The implication is that if creativity requires blind variation, then it is conceivable that creative performance may be increased by any technique that might serve to break the stranglehold of conventional expectations and simply increase the number of randomly generated variations. Some experiments have shown that this type of stimulation is indeed possible, (Simonton, p. 313). This supports the idea that "if the variation process is truly blind, then good and bad ideas should appear more or less randomly across careers, just as happens for genetic mutations and recombinations," (Simonton, p. 316). The theory thus implies that the creative mind can be enhanced by environments or efforts that encourage the individual to generate new variations and new combinations of ideas.

Simonton's historiometric studies of creative individuals support this concept. The data shows that quality of creative output is closely connected to sheer quantity. The more an individual produces, the more likely he/she is to stumble upon success. Also, the best creative products tends to appear at the point in a creator's career when he/she is most prolific overall. Thus, in the case of both the arts and sciences, creative quality is a "probabilistic consequence of quantity and the pattern of output is random and Poisson distributed". As Simonton explains,

> "the total lifetime output of a nineteenth century scientist predicts the probability that he
> or she will have an entry in a twentieth-century edition of the Encyclopaedia Britannica
> (Dennis, 1954a; Simonton, 1984b). Similarly, future Nobel laureates can be predicted on
> the basis of the total number of citations that scientists receive to their body of work
> (Ashton & Oppenheim, 1978), and yet the single best predictor of citations is the total
> number of publications (S. Cole & J. R. Cole, 1973; Simonton, 2002)….It is significant

that those who publish the most highly cited works also publish the most ignored works, so that quality is a probabilistic consequence of quantity," (Simonton, p. 3).

Simonton also explains that individual differences in creative productivity account for more variance in output in a given career period than does age, so that truly prolific creators in their final years may be more productive than less notable contributors at their career peaks.

For more detail on the Darwinian view of the creative process, Simonton's articles "*Creativity as Blind Variation and Selective Retention: Is the Creative Process Darwinian?*" (1999) and "*Scientific Creativity as Constrained Stochastic Behavior: The Integration of Product, Person, and Process Perspectives*" (2003) are highly recommended. For a clear and concise summary of the role of productivity and the potential relationship between productive output and creative success, see pages 89 – 101 of **The Medici Effect** which summarizes Simonton's research and explains how creative outcomes result when people are able to break down the associative barriers that exist between disciplines or areas of knowledge. When this breakdown occurs, individuals can enter what Johansson terms "the Intersection" between fields, where the number of new combinations of ideas is staggeringly high. Living and breathing at this Intersection explains the high level of output of successful creators. By pursing the best of these numerous idea options, creative individuals have a shot at success.

Motivation

"Even more than particular cognitive abilities, a set of motivational attributes—childlike curiosity, intrinsic interest, perseverance bordering on obsession—seem to set individuals who change the culture apart from the rest of humankind," (Nakamura & Csikzentmihaly, p. 258). Indeed many theorists see motivation as the most important component of creativity. Much of Amabile's work has focused on the role of intrinsic motivation and ways in which intrinsic motivation can be enhanced in the classroom and workplace. Amabile explains, "[We] have found so much evidence in favor of intrinsic motivation that we articulated what we call the *Intrinsic Motivation Principle of Creativity*: people will be most creative when they feel motivated primarily by the interest, satisfaction, and challenge of the work itself—and not by external pressures [i.e., extrinsic motivation]," (Amabile, p. 78).

Numerous articles and studies document how intrinsic motivation enhances creativity and how extrinsic rewards hamper it. The principle in operation is best illustrated by Amabile's maze analogy. The extrinsically motivated person will take the shortest, most obvious path to get to the reward at the finish line. The intrinsically motivated person will explore various pathways and alternatives, taking his/her time and enjoying the process along the way. This exploration will lead to novel, alternative solutions, some of which will turn out to be more appropriate and successful than the original, obvious path.

One psychological experiment highlights the effect: one group of children were told they could play with a Polaroid camera (a reward) if they promised to tell a story when they were done. Children in a second group were told that there were two unrelated activities: 1) playing with the camera and 2) telling the story. The first group scored significantly lower on creativity throughout the activities, suggesting that extrinsic rewards can actually hinder creativity due to the negative feelings resulting from external control.

However, through the course of her research and the contributions of other theorists, Amabile has recently modified her stance on the intrinsic-extrinsic question. The revised view acknowledges that there are probably two types of extrinsic motivation: synergistic (motivations that are informational or enabling) and non-synergistic (motivations that are controlling). Synergistic extrinsic motivators can support and enhance intrinsic motivation. Non-synergistic ones hinder it.

Nonetheless, the types of extrinsic motivations that are most likely found in the workplace and classroom are non-synergistic and not easily avoided. Thus, Amabile's research on motivation implies that, in the educational contexts, the impact of grades or praise as reward for schoolwork should be reviewed in light of their impact on creativity. Amabile suggests that if assessment is necessary, using it as informational – as a tool for improvement, rather than as a judgment, may reduce the feeling of external control. Additionally, she suggests that consideration should be given to the "motivation-work cycle match". Different types of motivation play a role in different parts of the creative process. Intrinsic motivation is particularly important when the emphasis is on novelty. If greater emphasis is on persistence, synergistic extrinsic motivators may play a role. Additional roles for extrinsic motivators are that they can help an individual

sustain energy through the difficult times necessary to gain skills in a domain. Extrinsic motivators may also serve to bring people in contact with a topic to engage their intrinsic interest.

Amabile's theory of intrinsic motivation is reflected in Howard Gardner's research on the lives of historically successful individuals. High degrees of intrinsic motivation in great creators such as Einstein, Picasso, and Gandhi play out in their holistic involvement in and commitment to their work. One thing that all the creators that Gardner reviewed had in common was that they had sacrificed a great deal on a personal level and are wholly and completely consumed by their work dedicating all their time, energy, effort and emotion to a problem, sometimes non-stop for days or weeks on end. This leads to what Gardner terms the "Faustian bargain" of creativity: To gain superior professional attainment, individuals must sacrifice a more well-rounded personal existence, neglecting family and social life. However, Gardner also qualifies his point: "The question remains whether and to what extent some aspects of the holistic pattern hold for individuals who are also creative, but in a more limited sense, such as the successful entrepreneur, the original strategist and the R&D inventor," (p. 215-216).

Closely related to motivation is the "positive psychology" perspective on creativity. Gardner explains that creative individuals are characterized by their disposition to convert differences into advantages. They reflect on their goals. They analyze their strengths and weaknesses and then leverage their abilities to the optimum. They frame apparent defeats or failures as prods to greater achievement in the future. They also demonstrate intrapersonal intelligence – the ability to understand and guide one's own creative process and to put checks on illusory and/or emotional interferences in the process, (Gardner, p. 223). They are comfortable with taking risks and show persevere, even in the face of doubt and misgivings of others.

Nakamura and Csikzentmihaly promote the linking the positive psychology/intrinsic motivation view with a deficit psychology model to give a fuller picture of the complexities of the creative mind: On one hand, a deficit model views creative efforts as a defense against personal inadequacy and feelings that the self is flawed and destined to failure. On the other hand, a meaningful purpose can also serve as a motivation for creativity. For example, the exercise of skills can be a source of joy. Integrating a deficit and strengths model, the

resulting systems model asserts that creativity is the outcome of the interaction between the innovating individual, that individual's domain of knowledge and the social field that judges the individual's contribution to the domain. In a deficit model, lack of affirmation of work from the social field might discourage persistence. Under a strengths perspective, the innovator may use the social field as a source of information about work, but also give equal or greater weight to signs of progress and success in the activity itself. The discussion highlights the importance of finding meaningful challenges and domains of activities that can serve as a source of increased self-worth and a shift towards strength-based motivation and away from deficit based motivations. Potential implications of this viewpoint are that the educational system should provide greater focus on helping students identify areas of interest and passion – areas where they can achieve the a state of flow which leads to growth of skill and confidence.

Finally, closely linked to the role of practical thinking in creativity is the importance a meta-cognition of the creative process and an explicit decision to pursue a creative path. In his article "*Creativity as a Decision*", Sternberg stresses this importance and explains that one of the main challenges of creativity research is to uncover general truths about the characteristics of creative people despite the fact that "so many things seem to be true about at least some creative people, although not necessarily all of them. For example, some seem surely to be characterized by high self-esteem, but then others seem just as surely to be characterized by low self-esteem," (Sternberg, p. 1). Sternberg asserts that perhaps the one consistent attribute about successfully creative people is their explicit decision to pursue creative a creative path. He explains:

> "People who create decide that they will forge their own path and follow it, for better or for worse. The path is a difficult one because people who defy convention often are not rewarded. Hence, at times, their self-esteem may be high, at other times, low.…At times, they may feel curious, at other times, less so. But if psychologists are to understand and facilitate creativity, I suggest they must start, not with a kind of skill, not with a personality trait, not with a motivational set, and not with an emotional state, but rather, simply, with a decision.…If psychologists wish to teach creativity, they likely will do better to encourage people to decide for creativity, to impress on them the joys of making this decision, and also to inoculate them for some of the challenges attendant on this decision," (Sternberg, p. 1).

Sternberg's suggestion echoes the sentiments of other theorists in the idea that not only should educational systems attempt to enhance creativity, but should also directly teach students about

the field of creativity itself so they gain an explicit awareness of their own creative potential, as well as and understanding of methods of enhancement. With this knowledge, they can both make an informed decision to pursue creative activities and at the same time, better control and direct the development of their abilities. Nickerson echoes Sternberg's suggestion:

> "Students need to believe that creativity is determined by motivation and effort to a significant degree. They need to understand that creative products are seldom produced without intent and effort, that there is considerable evidence to support the belief that most people have potential they never realize and that persistent effort to develop that potential is likely to be successful…. Students need to know too that…truly outstanding creative works in science and art have often taken many years – sometimes the better part of a lifetime – to produce…They need to understand that if one really wants to be creative in a substantive way, one must be prepared to work at it," (Nickerson, p. 416).

Furthermore, meta-cognition of the creative process should involve managing one's emotions, cognitive resources, learning one's strengths and weaknesses and managing time allocating to creative pursuits.

Section Summary

In sum, within the three main components of the sources of creativity in individuals it appears that the following are key to individual creativity:
- o Knowledge: the balance between breadth and depth of knowledge.
- o Thinking: a strong ability to generate novel ideas by combining previously disparate elements. This "synergistic" thinking must be combined with analytical and practical thinking.
- o Personal motivation: the appropriate levels of intrinsic motivation and passion for one's work combined with appropriate synergistic motivators and self-confidence.
- o Environment: a non-threatening, non-controlling climate conducive to idea combination and recombination, such as the "intersection".
- o An explicit decision to be creative along with a meta-cognitive awareness of the creative process can go a long way in enhancing long-term creative results.

What Educational and Pedagogical Techniques Have Proven Effective in Promoting Innovation and Creativity?

Innumerous programs, courses, workshops and techniques have been developed to promote creativity and to enhance the cognitive functions that supposedly support it. Some of these programs can be explicitly labeled as creative studies while others promote creativity as a bi-product of other efforts or processes. To give a sense of the wealth of creative training opportunities available, McDonough and McDonough found that out of 1,504 colleges reviewed, 76.5% of them offered creativity courses. In addition to university level programs, there are creativity specific training programs and workshops. Arthur Cropley mentions that more than 250 of these have been developed. For a list of some of the more popular programs, see page 144 (table 7.1) of Cropley's book, **Creativity in Education and Training** or page 415 of Jane Piirto's book**, Understanding Creativity**.

Raymond Nickerson's article, "*Enhancing Creativity*" in Sternberg's **Handbook of Creativity,** reviews multiple creativity programs and addresses the key questions, can creativity be enhanced, and if so, how? Nickerson believes the answer to the first question is yes, but that the *how* is not well understood, although there is some speculation that is worth exploring. A Venezuelan example, Project Intelligence, aimed to promote a range of abilities including inventive thinking among seventh-graders in 1982-3. The inventive thinking section consisted of nine lessons on the idea of design, including analysis of designs of common objects with a view to understanding the functionality of design. Students in the participating group outperformed the control group for all themes. Also, to test the programs impact, students were given an open-ended design problem (to design a table for an apartment that was too small for one of typical size). The participating group's designs scored better on all counts than did the control groups. Although this study didn't measure the long term impacts of the program, it does indicate that classroom instruction can have a positive impact on creative abilities (Nickerson, p. 403-404).

Nickerson, Cropley and Piirto all mention multiple idea-getting techniques, including brainstorming and divergent thinking methods and other instructional approaches to increasing creativity. Brainstorming is one of the most popular techniques used to induce creativity and so deserves special mention. Brainstorming was originally suggested by the classic creativity

studies guru, Alex Osborn in his 1957 book, Applied Imagination. However, the technique is often implemented incorrectly. Studies show that due to evaluation apprehension and blocking, fewer ideas are generated in brainstorming groups than would be generated if participants thought alone and wrote ideas down. To be done correctly, brainstorming sessions should first involve 15-20 minutes for people to think individually and write their ideas on an anonymous piece of paper which is then handed in to the facilitator. All ideas are then discussed openly with a view to first considering how each one could be feasible rather than the more common approach of seeking to criticize or find the reasons why it wouldn't work, (Johansson, p. 110).

One attempt to assess the effects of creativity training is Scott, Leritz and Mumford's study. The study reviewed 156 creativity training programs, categorized them into clusters, and assessed their effectiveness. Four themes emerged in the training programs: 1) idea production training, 2) imagery training, 3) cognitive training and 4) thinking skills training. Idea Production Training is the most common and traditional method. However, in terms of effectiveness, it is apparently less effective than Creative Process Training, Conceptual Combination Training and Critical/Creative Thinking Training (which are all appropriately designed forms of cognitive training). Conceptual emphasizes conceptual combination, convergent thinking and techniques to stimulate new combinations such as analogies and metaphors. Creative Process Training seeks to develop creative thinking through convergent and divergent thinking. It's typically lengthy and involves practice on realistic exercises accompanied by lecture and discussion. Critical/Creative Thinking stresses problem finding, idea evaluation, idea generation, brainstorming and meta-cognition. For more information on which creativity training programs fall into these categories and their characteristics, see article, "*The Effectiveness of Creativity Training: A Quantitative Review*" by Scott, Leritz and Mumford.

Most creativity programs, such as brainstorming and other idea-getting techniques, address only one or a few of the sources of creativity, and show modest positive outcomes, if assessed. As an alternative, Cropley suggests a more holistic approach: an educational program should be tailored to address an individual's creative potential, psychological aspects of creativity, thought processes, such as divergent thinking, environment and special characteristics of the task and desired solutions.

Despite the existence of so many creativity training programs and efforts, in the formal education system, current classroom practices don't focus enough on promoting creativity and innovation and even sometimes serve to destroy it. Cropley explains that teachers often view the creative, maverick personality as a troublemaker, stifling the student's ability. Additionally,

> "Conventional education systems often hinder the development of skills, attitudes and motives necessary for production of novelty. Among other things, they frequently perpetuate the idea that there is always a single best answer to every problem and that this can readily be ascertained by correct application of set techniques and conventional logic that need to be learnt and then reapplied over and over again," (Cropley).

Several theorists provide suggestions for modifying educational programs in order to correct for this shortcoming.

- ➤ Amabile's book, **Growing Up Creative** explains,

    > "The standard tools we've relied on for so long in parenting and teaching—evaluation, reward, competition, and restriction of choice—can in fact destroy creativity…we must perform a balancing act. We must use enough constraint to give children a sense of predictability, but not so much that children feel the only reason they're doing something is because they have to….The trick is to set limits in a way that maintain their intrinsic motivation," (Amabile, p. 79).

- ➤ Amabile's research has shown that controlling classrooms reduce intrinsic motivation. Rules should be presented informationally: "Children should be given a behavioral constraint along with a good reason for the constraint and an acknowledgement that they might not be enthusiastic about obeying, without a lot of controlling language," (Amabile, p. 146).

- ➤ Focus grading and evaluation on "what did you learn" and not "how did you do" and let children participate in evaluating their own work. Make it informational rather than controlling. Or, have students try again instead of grading them immediately. Help students not to fear failure and to understand they can learn from it.

- ➤ Nickerson mentions that allowing opportunities for choice is important to creativity. Students will be more motivated to work on projects they have chosen for themselves. Practically, teachers will need to define problems some of the time. However, if students have practice with problem finding, and define at least some portion of their own challenges, motivation and creativity can be enhanced.

- ➤ Sternberg's 1996 book, **How to Develop Student Creativity**, lists 25 steps that can promote creativity in the classroom:

The Prerequisites 1. Modeling Creativity 2. Building Self-Efficacy **Basic Techniques** 3. Questioning Assumptions 4. Defining and Redefining Problems 5. Encouraging Idea Generation 6. Cross-Fertilizing Ideas **Tips for Teaching** 7. Allowing Time for Creative Thinking 8. Instructing and Assessing Creativity 9. Rewarding Creative Ideas and Products **Avoid Roadblocks** 10. Encouraging Sensible Risks 11. Tolerating Ambiguity 12. Allowing Mistakes 13. Identifying and Surmounting Obstacles	14. **Add Complex Techniques** 15. Teaching Self-Responsibility 16. Promoting Self-Regulation 17. Delaying Gratification **Use Role Models** 18. Using Profiles of Creative People 19. Encouraging Creative Collaboration 20. Imagining Other Viewpoints **Explore The Environment** 21. Recognizing Environmental Fit 22. Finding Excitement 23. Seeking Stimulating Environments 24. Playing to Strengths **The Long-Term Perspective** 25. Growing Creatively 26. Proselytizing for Creativity

In addition to these piecemeal suggestions that can be integrated into any curriculum, project-based or problem-based learning (PBL) represents a greater paradigm shift and an overhaul of traditional methods. In addition to enhancing a broad range of thinking skills, PBL many prove effective for creativity. PBL was originally developed in medical schools as a result the recognition that being an effective doctor involves much more than factual knowledge of anatomy and biology.

Few people agree on the precise definition of problem-based learning and how it differs from project-based learning. In fact, the two terms are often used interchangeably. The primary and little-known difference between the two is that project-based learning may be ill-defined, but typically begins with an end product or artifact in mind. Problem-based learning also begins with an ill-defined problem to solve, but often in a case study format. The outcome of information gathering, organization and analysis may or may not be an end product. Furthermore, the project-based approach tends to be associated with K-12 education while problem-based is more often found in medical schools or other forms of professional training. However, both approaches are used in a wide range of contexts and most often, the distinction is blurred and a lesson may use both approaches in combination. For more on the differences

between problem and project-based learning, see the Project-Based Learning with Multimedia website, http://pblmm.k12.ca.us/PBLGuide/PBL&PBL.htm.

The PBL process begins by breaking students into teams, giving them an ill-structured, ill-defined problem, with some information, but not enough to work out the case. The teams should discuss what they know and what they don't, so they can define the core of the information they need to gather and then establish how they will resolve the issues. After gathering information and developing one or more solutions for the problem, teams should engage in self-assessment. To be effective, PBL should be interactive between students and teachers and should involve minimal lecture. Teachers should serve as facilitators of the teams' learning process, or as metacognitive coaches, but not as the authoritative source of knowledge. Maintaining the role as a guide and resisting the temptation to put students on the right path is key to the effectiveness of the method. Also, the teacher should establish an environment where it's okay to make mistakes, (Mierson & Freiert, p. 1-4).

The "ill-definition" of the problem is a key aspect of PBL that differentiates it from more traditional approaches. In typical classrooms, students are given problems after the relevant information has been taught, "giving the misleading impression that problems only arise in circumstances where all information needed for solution building is available. In PBL,…the order of learning is *inverted* to reflect real life learning and problem solving." (Greenwald, et al, p. 55). Furthermore, ill-defined problems allow students to undergo a process of problem finding through which they may define a problem themselves in a way that engages them and is relevant to their particular learning level and style. For details on the steps involved in a successful PBL effort, see Greenwald's article, "*Problem Based Learning in Science*". Pages 57-61 offer ten steps to guide students through the process. See http://www.cct.umb.edu/tfcfb.pdf.

In his book **Successful Intelligence**, Robert Sternberg also endorses the importance of the ill-structured problem:

> "Problems with clear paths to solution are sometimes termed *well-structured problems* (e.g., "How do you find the area of a parallelogram?"), whereas those without clear solution paths are termed *ill-structured problems* (e.g., "How do you succeed in a career of your choice?"). Conventional, IQ-based academic intelligence is customarily measured by the ability to solve well-structured problems, whereas real-world successful intelligence is the ability to solve ill-structured problems. An unfortunate feature of much

education today, as well as the assessment of educational progress, is its overwhelming emphasis on well-structured problems." (Sternberg, p. 171).

One example of a successful PBL case is Durtschi's, "The Tallahasee BeanCounters" used in graduate-level accounting courses. Students take on the role of auditors investigating fraud amongst the managers of a baseball team. Students consistently report this case as their favorite part of any course in which it has been used due to its practical, real-world feel, (Durtschi, p. 9). Understanding the elements that make this case successful and how it can be replicated in other disciplines could be useful.

For further examples of PBL ideas and scenarios, see www.pblnet.org. This site's Design Challenge Database and Design Resource Database offer examples of projects by grade level, theme, etc. Also see Bob Pearlman's site on PBL best practices which is a collection of a wide variety of resources on the topic: http://www.bobpearlman.org/BestPractices/PBL.htm.

While the impacts of PBL on education in general and on creativity in particular are not fully understood, there is an indication at least, that if designed properly, PBL can positively influence learning outcomes. It is reasonable to suggest that real-life problems (or simulations of real-life problems) have the potential to increase motivation by allowing students to feel their learning is more relevant and meaningful to their own lives. They take greater interest in the process and have more of a stake in the outcome. Also, working in small groups, students explain things to each other and reinforce their own learning, building a stronger knowledge foundation that can feed into creativity.

Proof of the value of PBL exists: A study at McGill University in Canada found that,

> "Compared with conventional students, problem-based learning curriculum students place more emphasis on meaning than on memorising, are more confident and self-directed in their acquisition of skills, use a more in-depth approach to learning and employ a hypothetico-deductive mode of reasoning which works backward from the starting hypothesis," (Lipwell, p. 52).

In terms of creativity, a study of 158 first-year polytechnic students in Singapore measured the effects of a Problem-based Creativity Learning Program (PBCL) measured by a Cognitive Abilities Test (CAT) non-verbal battery. This test focused on students' discovery of and flexibility to manipulate relationships expressed in figural symbols or patterns and is made up of

three sub-tests: Figure Analogies, Figure Classification, and Figure Synthesis (30 items). The results indicate that within each of the courses the PBCL programme appears to produce significant gains in creativity, (Seng, p. 3).

In addition to these systemic reviews of creativity research, several individual programs have come to the attention of this effort. These programs represent clear, deliberate efforts to alter and improve the educational processes so as to best prepare students for innovative and creative careers in the global economy.

Don Treffinger, President of the Center for Creative Learning, suggests that there are two programs that typify excellent application of PBL concepts to enhance creative thinking: First, "**Destination Imagination**" is a a non-profit organization that runs a global program. The organization poses a set of project-based challenges and groups of kids from around the world choose one problem to address working in teams. They spend months preparing in their home towns. The top groups come together for the Destination Imagination Global Finals every year. Over 10,000 people attend and compete in a range of problem-based learning activities, such as building a load-bearing structure, creating a vehicle, writing a performance piece or exploring history. Also, some problems are handed out and must be solved quickly to enhance rapid flexible thinking and on-the-fly creativity. More information is available at http://destinationimagination.org/learn/whatwedo.hitm.

Second, Don Treffinger also mentions "**Future Problem Solving**". Also run by a non-profit organization, this program immerses youth in a variety of realistic problem-solving efforts including: scenario writing, individual, team-based, action-based and community problem solving. The program is well-funded and provides opportunities for involvement in actual community issues, thus going beyond mere simulation. Instead, students work with local community issues so the problems are real and relevant to the participants' immediate environment. The program arms participants with the following model for approaching problems:

1) Identify Challenges in the Future Scene
2) Select an Underlying Problem
3) Produce Solution Ideas to the Underlying Problem

4) Generate and Select Criteria to Evaluate Solution Ideas

5) Apply Criteria to Solution Ideas

6) Develop an Action Plan

For more information, see http://www.fpsp.org. In addition, the website provides information on the link between this program and National Curriculum Standards. See http://www.fpsp.org/Standards.pdf

Taking a closer look at these well-regarded examples of project-based learning may provide greater insight into the types of program that can have real impact on students' creative problem solving abilities.

Another program that merits closer review is the joint effort between the INSEAD School of Business, Europe's premier business school located in Fontainebleau, France, and the Art Center College of Design in Pasadena, California. The INSEAD alliance was first proposed by a former graduate, on the board of both schools. The first group of eight students from each school have just completed the INSEAD portion of the program in France and are now beginning the second half in Pasadena. So far, the effort has been very successful. One MBA student is quoted as having said, "I will never do another project without having a designer on the team."

In addition, the Art Center offers several other programs of interest. This includes a summer design institute for elementary school children and programs focused on design in science, technology, medicine and urban planning. For example, design can be applied to practical urban planning decisions such as street layout and signage, public transportation routes and the location of certain services within relation to residential and commercial areas. Whereas design is often thought of as mere aesthetics, this is a clear example of how design solutions are much more than that – combining the aesthetic, the functional and the practical.

These Art Center programs represent efforts to infuse the design program with other kinds of thinking and to share design thinking with other disciplines at the same time. In bringing together previously disparate elements and combining them in unique and useful ways, the Art Center's programs are reflective of dominant theories of creativity and innovation. Erica Clark,

Director of the Art Center's International Programs has expressed interest in further discussing their programs with NCEE and has extended an invitation to visit the school in Pasadena.

Daniel Pink's book, "A Whole New Mind" supports the concepts embodied by the Art Center's programs. Pink explains that The MFA is the new MBA. Corporate recruiters have now begun visiting the top art schools. British organizations such as the London Business School and the Yorkshire Water Company have established artist-in-residence programs.

Pink's book also stresses the importance of design in the new era, what Pink terms "the conceptual age". He explains that it is no longer sufficient to innovate products that are merely functional but they must also be beautiful and engaging and infused with design practicality. He cites educational programs that promote design-related skills. For example, he mentions the Charter High School for Architecture and Design – a tuition free Philadelphia public school founded in 1999 with a design centered curriculum. The school marries design to Math, Science, English and Social Studies. The school's teachers and administrators recognize that not all the students in this program will go on to become designers or architects, but they don't think that matters. The design thinking that they learn can and should be applied to any discipline. Another particularly interesting aspect of Daniel Pink's work is his discussion of the role of "play" in productivity. Other theorists also have mentioned a link between a playful attitude and creative success. Pink explains that The ability to play and integrate play into work and education is key to creativity. Games and human joyfulness play a role in productivity. Video games are an often overlooked opportunity for developing a broad range of thinking skills and learning. Video games seem to sharpen visual perception and the ability to process information simultaneously. The US military, for example, is leveraging this by using video games to simulate reality. The Entertainment Technology Center at Carnegie Mellon University is a collaboration between its College of Fine Arts and School of Computer Science. The program offers a master's in entertainment technology and is a clear example of cross-disciplinary creative skill development. Taking a closer look at this program and its curriculum could prove worthwhile. Nickerson also highlights the importance of the role of play:

> "Investigators have suggested that creative children tend to be more playful than their less creative peers….finding pleasure in playing with ideas appears often to be a characteristic of creative adults as well. There is a great deal of whimsy and play, for

example, in much of the thinking that scientists do…imagining oneself, for example, riding on a photon at the head of a beam of light," (Nickerson, p. 410).

Playfulness may also be accompanied by a childlike naïveté which many great scientists appear to embody. This involves persistent curiosity and not taking things for granted. Nickerson concludes that "there is little a teacher can aspire to do that will be more important to the quality of the intellectual lives of his or her students throughout their adulthood than to foster in them a deep sense of wonder about the world and existence," (Nickerson, p. 410).

Another program of particular interest is the USC Film School's Graduate Program in Production. An interview with Richard Codding, as student in the program, revealed that the curriculum begins by teaching students the basics of digital video and storytelling through practical experience. The program involves minimal lecture and students are required to produce films every semester, increasing in complexity and length over the course of the curriculum. The courses serve to replicate real-world experience by having students take on roles of director, producer, writer, etc. as would be the case for a professional Hollywood film project. Richard feels that the program helps enhance creativity through the critique process – both faculty and peer review of each film, and also through the collaborative, teamwork process which allows students to bounce ideas off each other in order to refine and develop their films. Students complete the program with the full set of skills and knowledge in the craft that will permit them to be productive filmmakers. For more details on this program, see the interview notes.

Finally, "*re think*", an article from the International Technology Education Association (ITEA), discusses a program in New Zealand that using three techniques, intimacy, synergy and translation. These techniques are similar to those proposed by many creativity training programs. Intimacy means locating the project in something personal to enhance intrinsic motivation. For example, a group of 15-16 year olds were asked to make a play-based gift for someone they loved and the work had to profile the signature of the designer. Synergy involves presenting thinkers with a problem and asks them to marry it with an unrelated theme or object. For example, students were asked to take an adjective from a hat and join it with the concept of time to design an original clock for under $10. Translation refers to taking a concept from one arena and applying it to another. Students are asked to take an idea from their childhood and make a bowl to contain it. The article explains that through the above efforts, students

"became passionate, committed and courageous thinkers. Technological capability and technological literacy surfaced from inside the act of making, but more importantly interfaced with wider learning principles like empathic design, personal signature and the importance of drawing on an emotional commitment to problem solving," (Ings, p. 13).

Finally, an educational program that most clearly integrates many of the concepts emphasized by the theoretical research is the "Creative Problem Solving Method" (CPS) promoted by the Center for Creative Learning. This approach has been in existence for several decades and thus has had time to evolve and be refined through years of research and implementation. The current version of the method is CPS 6.1 and it addresses 3 broad areas in the development of creative solutions:

1) Deliberate use of **process** and tools to solve problems
2) Consideration of dynamics in the **environment/climate**
3) Consideration of **personal problem-solving style**

In terms of process, CPS provides students and professionals with a set of tools that they can personalize and customize to apply to tasks and projects and to solve problems. Older models promoted fixed processes which suggested that every problem solving effort required a specific set of five steps. While this method proved too rigid, other programs erred on the opposite extreme, ignoring process altogether and assuming if you throw enough content at students, they'll devise an adequate process themselves. But, it doesn't always make sense to re-invent process on the fly every time. Thus, by providing tools that can be used flexibly and where appropriate, the CPS method finds the happy medium between these two extremes. It both provides standard tools and teaches the student to adapt them appropriately or develop new methods when needed.

This concept of process can be applied within PBL programs to ensure their effectiveness. CCL sees project/problem-based learning not as a method for creativity, but rather as a context within which students can become engaged in a challenge. The problem is that as implemented, many of these programs are short on offering process tools to address the problem. The challenge and the means to address it should be more integrated as a package. As students are equipped with multiple thinking tools, they develop the capacity to apply the various modes of thinking to problems, where most appropriate. I this sense, a meta-cognitive process is involved in CPS: As Treffinger describes it, "Think about what you're thinking while you're thinking it".

In terms of the dynamics within an environment such as the classroom, CSP encourages factors that support creativity such as freedom, risk-taking, deliberating on ideas, withholding judgment of people, and a climate of challenge and high goals.

In terms of personal problem solving style, CPS takes three dimensions into account. Teams need to leverage the potential benefits of all these personal styles and create teams individuals who can balance each others perspectives on these three dimensions.

1) **What's your orientation to change**? Some people are explorers and some are developers. Explorers love new, radical and wild ideas. Developers prefer gradual, incremental change that is carefully orchestrated. There are benefits and appropriate uses for each of these approaches.

2) **How do you process change?** Is it internal and reflective or external?

3) **How do you make decisions?** Do you look for interpersonal harmony or are you task oriented?

The combination of dimensions of creativity that the CPS method addresses indicates that it may be one of the few holistic creativity programs in existence that also appears to be well grounded in solid theory and research. The program warrants further review. Don Treffinger, President of the Center for Creative Learning, is enthusiastic about the opportunity to promote creative thinking at the K-12 level and would be happy to speak further with NCEE.

Furthermore, CCL offers a variety of publications, training programs and consulting services. Many excellent resources are available on the website, http://www.creativelearning.com/. Of particular interest is CCL's **Summer 2005 Professional Development Institute on Creative Problem Solving in Education (July 13-15, 2005).** This teacher training program provides instructors with the tools and knowledge to integrate CPS into the classroom. The bullet points on the workshop agenda are spot on with the topics that this research would suggest most crucial for enhancing creativity. For more information, see http://www.creativelearning.com/PDF/2005SummerInstitutes.pdf

How Can Creativity Be Assessed and What Is the Impact of Assessment on Creativity?

If it is true that what gets tested is what gets taught, then in order for creativity to become a priority in the classroom, it must be assessed on par with the testing of more traditional skills and abilities. However, measuring creativity is undoubtedly more complex that measuring literacy or numeracy. While innumerous tests of creativity and creative thinking exist, most of these measure only certain aspects of creativity and frequently, their validity has not been fully tested. Finally, the suggestion has been made that instead of testing creative thinking skills, creative products today are the best predictor of future creative products. Thus, the best method of assessing creativity would involve the review of actual creative output such as student portfolios of creative works, developed over the course of a school year. Piirto agrees:

> "A more authentic type of assessment would be of actual products. Such a quality assessment could be of a 'creativity portfolio' that a student would assemble over the year(s). As an analogy, say there is a boy who can throw a ball from center field to home plate with great and accurate force. Observation would dictate that he would probably do well as a center fielder. Is there any need to give him a paper and pencil test to see whether he has spatial ability?" (Piirto).

Nonetheless, hundreds of tests have been designed to measure creative potential and creative thinking processes. These are discussed in detail in Cropley's book, **Creativity in Education: A Guide for Teachers and Educators**. Many of these aim to measure convergent and divergent thinking. They consist of open-ended questions and measure the following criteria:

1) fluency (quantity of answers)

2) flexibility (variability of idea categories in the answers)

3) originality (uncommonness of answers)

4) Some tests include scoring of elaboration (complexity and completeness of answers) or effectiveness (links to constraints in the real world).

Cropley reviews and discusses a number of tests that assess both cognitive functions as well as personality traits and motivation associated with creativity. Table 5.1 and page 125 list the measurable aspects of creative products and processes and summarize validity and reliability by test type. Cropley concludes:

"Validity coefficients are generally speaking lower than those for reliability, a common state of affairs with psychological tests. Not surprisingly, the highest inter-test correlations (construct validity) were found among divergent thinking tests (upto .70), which focus on a single aspect of creativity and are thus fairly unitary in their approach. Measures of personal properties correlate about .50 with each other….“Despite the relatively low predictive validity coefficients discussed above various authors both early and more recently have concluded that creativity test scores are better predictors of creative life achievements than IQs or school grades,” (Cropley, p. 127).

Cropley and Piirto both mention that Torrence tests of creative thinking are the best known and most widely used tests. The test-retest reliabilities and the predictive validity of these tests vary, but a many studies seem to indicate that the scores on this test do differentiate between students who subsequently attain creative success and those who do not (Cropley).

However, despite studies suggesting strong reliability and validity among these tests, many critics argue that the results are mixed, most tests only measure one aspect of creativity – divergent thinking, and lack of consensus of the definition of creativity further clouds this problem. Moreover, test administration can have a significant impact. Test scores change if administrators tell subjects to be original versus if they don't, (Piirto p. 393).

Due to these uncertainties, Piirto concludes, "I would not use divergent production tests at all, but would instead rely on consensual assessment of creative products and on a student's motivation to create. I would also not use an IQ cutoff (as in the Threshold Theory). I would not identify children for creative thinking ability, but would enfold the creativity assessment into domain-based assessment," (Piirto, p. 394).

In addition, Piirto is highly critical of the use of the "creativity checklist" which is a system used to assess creativity in many classrooms. Piirto explains that these checklists are often poorly designed and are difficult for teachers to implement effectively, especially if they aren't trained to do so. However, a review committee concluded that if checklists must be used (in Ohio and Georgia, for example, they are required), the only suitable ones are the Creativity Scale in *Scales for Rating the Behavioral Characteristics of Superior Students* (Renzulli, Smith, White, Callahan & Hartman, 1997) and the Creativity Scale in *Gifted and Talented Evaluation Scales* (Gilliam, Carpenter, & Christensen, 1996).

For further information on assessing creativity, both Piirto's and Cropley's books are useful. In addition, the Center for Creative Learning offers an assessment webpage with some potentially valuable resources, including a link to the abstract of their book, **"Assessing Creativity: A Guide for Educators"** which discusses this topic in depth. Also, the CCL's assessment website mentions the organization has completed brief reviews of more than 70 creativity assessment tools. For more information, see http://www.creativelearning.com/AssessingCreativity.htm

In addition to understanding how creativity may be assessed, it is also crucial to examine the potential impacts of assessment on creativity. With today's focus of high-stakes testing, a debate is raging around the effects that examination may have on teaching and learning in general, as well as on creativity specifically.

On one hand, supporters of high-stakes testing assert that these evaluations encourage students, teachers and schools to take education seriously. They suggest that the focus on standards has the potential to narrow the inequities in the US educational system.

At the same time, critics fear that the focus on performance has resulted in "decreased student motivation, increased anxiety, damaged self-concepts, a categorization and labeling of students and the creation of self-fulfilling prophecies," (Agrey, p. 2). Given the importance of motivation, confidence and an environment free of external pressures, it is reasonable to assume that the focus on testing could have negative impacts on creativity.

Furthermore, there is evidence that pressures are resulting in curricular reductionism that tends to squeeze out activities more geared towards creativity. There are countless examples of schools dropping or reducing time allocated to innovative projects such as student elections or mock hurricane tracking in favor of extra time for test preparation. Subjects such art, music, gym and even history get squeezed out of the curriculum in favor of scheduling arithmetic and vocabulary practice for the tests. While math and reading test scores have gone up in some instances, there is a large contingency of critics who fear that these extra points have come at the sacrifice of other extremely important goals. Critics are concerned that American inventiveness will suffer as a result:

"students 10 years from now will be less self-motivated, less creative and less excited about learning. They worry that future students will think if something isn't on a test, it doesn't matter… This could kill innovation. Company executives bred on bubble answers would stick closely to what they know and what's been done, possibly latching on to a new idea here and there but rarely having their own. Medical research would stall; advances in technology would stumble. Poems and novels would languish undiscovered in the brains of our young people…. this would stifle the economy by crushing creativity and drive," (Muzslay, p. 1).

On the other hand, proponents of the high-stakes testing system argue just the opposite – that teaching and learning will benefit from the incentive system that testing creates. Some studies show that accountability is linked to improved performance in basic education. This focus on basics like math and reading, it is argued, lays the foundation of knowledge for an increased potential in creativity. Proponents assert,

"In the future, this academic achievement and creativity would lead to innovation, pushing fields such as information technology, biotechnology and nanotechnology…. Each bit of extra schooling would translate into bigger paychecks and higher productivity, which would also spur industry and business," (Muzslay, p. 2).

Which of these two contradictory views is correct? Most likely, there is an element of truth in both. A strong grounding in basic skills is necessary, both for creativity and a broad range of other capabilities. However, if we take this focus too far, there will be a price to pay as motivation and exploration dwindle when engaging projects are crowded out of the curriculum in favor of test practice.

How can we strike the right balance? The idea of using multiple measures to assess student progress seems like a more well-composed option than current practice. While traditional standardized tests do play an important role in ensuring accountability and basic skill development, these tests could be supplemented. Sternberg explains, "If our schools want to encourage creativity and the display of creative intelligence, they need to include in their assignments and tests at least some opportunity for creative thought," (Sternberg, p. 207). Sternberg explains that this principal can be applied in any course within any subject area.

Beyond integrating creative tasks into teacher-designed tests, with either a range of creativity tests, or with the most popular idea – portfolios of creative work. While critics suggest that judging creative products is too subjective, and while the judgment of creativity cannot

achieve the same level of objectivity as a multiple-choice test, many studies have shown high degrees of inter-judge reliability in the assessment of creative products. And, as Sternberg says, "Better that students do creative work that is evaluated with somewhat less objectivity than that they never be allowed to do creative work," (Sternberg, p. 212). The idea of assessing portfolios of work has broad support. As Dan French, the Executive Director of the Center for Collaborative Education in Boston, explains:

> "An August 2000 Gallup Poll produced for Phi Delta Kappan found that only 13% of the public believed that a single standardized test was the best way to measure academic achievement, while 85% felt that the best way was either a combination of standardized and teacher-designed tests or portfolios of students' work and other demonstrations of academic competence," (French, p. 2)

French also provides examples of assessment methods that incorporate a wider variety of tools so as not to rely to heavily on one specific test or set of tests. He sites *Turning Points*, a New American Schools middle school reform model. He explains that in *Turning Points* schools, teachers devise a wide array of assessments–including portfolios, exhibitions, theses, and demonstrations–in which students are required to exhibit understanding, analysis, synthesis, evaluation, and application. These are assessed by external panels of reviewers.

French also sites The Boston Pilot Schools Network, a group of 13 public schools that have charter-like autonomy over their resources and have developed a helpful framework for thinking about assessment and accountability. Their system is relies on the following principles:

- Provide multiple ways of assessing student competency in meaningful ways.
- Eliminate secrecy so that all students, families, and the public understand what students should know and be able to do.
- Develop the assessment system by those working most closely with students.
- Embed good assessment in curriculum and instruction that engages students in work that has a public purpose.
- Help students become independent, self-reliant, and thoughtful learners through good assessment.
- Promote reflective practice in teachers through good assessment (Pilot Schools Network, 2000).

Applying these or similar principles, while specifically keeping the goal of creativity in mind, could lead to a more well-rounded set of assessment methods.

What Techniques Stimulate Creativity and Innovation in the Workplace?

Most literature on creativity and innovation in the workplace targets an audience of managers and business leaders and focuses on methods to foster organizational climates conducive to innovation. A recurring message is that companies have historically approached the creative climate in different ways and "there is no recipe for systemic creativity," (Mauzy & Harriman, p. 35). One essential element, however, is that top management holds the power to set the tone and thus plays a key role in whether a company will be innovative or not. Management "must ask for technical innovation, demand it, encourage it, stimulate it, fund it, and reward it," (Hastie, p. 156). Management must truly want and be committed to creativity and be willing to sacrifice short term results for innovation.

In designing a workplace environment conducive to innovation, management must consider the same elements that are key to creativity in individuals: knowledge, creative motivation. Amabile explains that in the workplace, it is easier to influence intrinsic motivation than to influence knowledge or creative thinking styles which are longer term pursuits. She suggests that management can bolster intrinsic motivation through focus on the following six areas:

- **Challenge**: Match people to jobs where challenge/stretch is optimized: "not so little that they feel bored but not so much they feel overwhelmed and threatened by a loss of control….One of the most common ways managers kill creativity is by not trying to obtain the information necessary to make good connections between people and jobs." (Amabile, p. 81).
- **Freedom**: Give people autonomy concerning the process, not necessarily the end. In fact, clearly specified strategic goals often enhance people's creativity, but freedom in process enhances sense of ownership. At the same time, programs that do employees to choose their goals have also been known to enhance creativity. At 3M, employees have 15% of their time to pursue their own projects. These projects routinely spark successful outputs. (Mauzy & Harriman, p. 124).
- **Resources**: Resources in both time and money are important. Under some circumstances time pressure can enhance creativity by increasing urgency and sense of challenge, but fake or impossibly tight deadlines create distrust and cause burnout. In fact, in a study of 177 employees in 22 projects from seven companies, Amabile, discovered that people are less

creative under time pressure, despite the fact that they think they are more so. Allowing time for evaluation and playing is key (Johansson, p. 112).

- **Work-Group Features**: when teams include people of varied perspectives, ideas combine and combust in interesting ways. Teams must share excitement, be team players, and recognize the value that each member brings to the table. Creating such teams requires managers to have excellent knowledge of their people.

- **Supervisory encouragement**: Freely and generously recognize creative work even before the commercial impact of that work is known. In general, people react to new ideas with a criticism bias. They think about why not to use it instead of how to explore it further. This creates a climate of negativity and fear and should be consciously overcome. As highlighted by multiple researchers and theorists, an organization's culture and attitude toward failure are key to promoting innovation. Organizations that tolerate failure and encourage risk-taking are more likely to see successful innovation.

- **Organizational support**: Intrinsic motivation increases when people are aware that those around them are excited and where there's information sharing and collaboration. Bad politics is to be avoided and gets in the way.

In addition to motivational approaches, collective knowledge and thinking processes are also key. Just as creative individuals must be capable of breaking down barriers between disciplines and combining knowledge in new ways, organizational creativity also results from both breaking and making of new corporate connections. According to Mauzy and Harriman, the key to this process lies in encouraging conflict and risk taking, and in encouraging the flow of information through the organization. Promoting diversity and flexibility among team members involved in such discussion is important.

One issue is that many managers equate creative ability with position or rank within the organization – assuming that only the higher ups have the best ideas and decision making abilities. "The effect of this management approach is to reduce the creative power of a 30,000 person organization to the top 100 leaders, a reduction of 300 to 1. To install systemic creativity, leaders must engage the other 29,900 employees...it must lead with a guide attentiveness rather than a manager's command and control," (Mauzy & Harriman, p. 121). At Tufts Health Care, for example, every department has a responsibility to generate new product ideas, in order to

stimulate creativity throughout the organization rather than isolating it in certain areas. The Guidant company is an example of the successful establishment of a creative environment. The company's three-pronged approach entails 1) a top-down approach involving seminars on entrepreneurship for management, 2) a bottom up approach involving company wide training focused on personal transformation and building skills necessary for creativity and innovation and 3) "brush fire teams" that undertook projects to create products or processes of immediate value. This combination proved successful (Mauzy & Harriman, p. 119).

Information flow is also a crucial aspect of promoting creativity throughout the organization, "creatively healthy companies have a high volume of diverse information that flows freely throughout the organization, increasing the likelihood of collision among beliefs, presumptions, possibilities and new fact," (Mauzy & Harriman, p. 75). Applying this concept even to the flow of unrelated pieces of information is important. For example, 3M requires all technologies and projects to be shared through the company's online communication system. Employees often find the catalyst for new ideas in this repository. Designing the physical workspace to create opportunities for interaction among otherwise separate workers may also help improve the flow of unrelated information to spark new connections leading to creativity. Company structure also plays a role in information flow. Ideas tends to move more easily through more fluid entrepreneurial companies with less structured roles and authority than they do through large, bureaucratic organizations. A rigid environment that adheres too strictly to procedure does not foster creativity. By contrast an humorous, jovial environment where there is comfort with ambiguity and a focus on ideas rather than careers is favorable to innovation. Job rotation and creating space for employee autonomy can help with this problem (Mauzy & Harriman, p. 78-81).

Complementary to information flow, management must also build diverse teams and create mechanisms by which individuals with different perspectives can interact productively. Unfortunately, the natural tendency is to hire employees with similar sets of backgrounds resulting in the "comfortable clone syndrome". Organizations falling into this trap have little chance at innovation. Where attempts are made to create diversity, the effort is often incomplete because people with varied backgrounds and thinking styles tend to have difficulty understanding one another. In practice, their differing viewpoints tend to lead to personal

disputes and the creative process breaks down. A successful manager must understand how to manage communication and build positive relationships so diverse individuals can engage in argument without feeling threatened. In "*Putting Your Company's Whole Brain to Work,*" Leonard and Straus explain that the successful manager figures out how to get different ideas and approaches to collide in a productive process called "creative abrasion". By deliberately creating diverse organizations and explicitly helping team members appreciate thinking-styles different than their own, creative abrasion can result in successful innovation. Managers can actively manage the process of bringing various cognitive preferences together to create heterogeneous, "whole-brained teams". Examples of companies with such teams include Xerox Park where social scientists work alongside computer scientists and Interval Research, a California think tank, which invites leaders from a variety of disciplines for sabbaticals in order to cross-fertilize ideas, (Leonard and Straus, p. 69). Through the use of established diagnostic instruments such as the Myers-Briggs Type Indicator (MTBI) or the Herrmann Brain Dominance Instrument (HBDI) which both reveal an individual's cognitive preferences, employees and managers better understand themselves and their colleagues. Joint discussion of the results of these tests can help employees with differing styles to come to agreement on how to work together, respect differences and leverage them in the process of creative abrasion. Understanding these differences diffuses tension as people realize that alternate approaches are not wrong-headed, but merely different and play a valuable role in the team's "whole-brain", (Leonard and Straus, p. 62-76).

Echoing the importance of information flow and flexible interaction among diverse employees, Johansson's, **The Medici Effect** explains that creative successes best occur at what he terms "The Intersection" – a place where wildly different ideas bump into each other and build upon each other.

> "For most of us, the best chance to innovate lies at the Intersection. Not only do we have a greater chance of finding remarkable idea combinations there, we will also find many more of them….The explosion of remarkable ideas is what happened in Florence during the Renaissance, and it suggests something very important. If we can just reach an intersection of disciplines or cultures, we will have a greater chance of innovating, simply because there are so many unusual ideas to go around." (Johansson, p. 20).

Breaking down associative barriers is fundamental to reaching the Intersection. Associative barriers are the chains of associations we cluster around a concept in order to categorize and

structure the stimuli in our environment. Building such barriers is the mind's way of creating order in a chaotic world. Researchers suspect that these barriers are responsible for inhibiting creativity. People with low associative barriers can make unusual connections which may eventually lead to successful creativity. These include individuals that have been exposed to various cultures, that are self-taught and/or that have less traditional backgrounds. Such people are less wedded to one way of doing things and are therefore more likely to arrive at unique Intersections. Management should consider these characteristics in its hiring practices as should employees in their professional development endeavors.

The "aha!" moments usually arise out of the combination of different concepts and also seem to pop up randomly in terms of when and where insights actually breakthrough. The "prepared-mind" is able to understand the significance of unintended happenings or discoveries. By diversifying occupations, interacting with diverse groups of people and going Intersection hunting, we can increase the chances that these fortunate happenings will materialize.

What if we need to break down associational barriers right now? One technique is to do an "assumption reversal". Take a challenge you face and think about the associated assumptions. Write them down and then reverse them. Finally, think about how to make the reversal meaningful.

In addition to designing a workplace environment conducive to creativity, the literature suggests multiple strategic and tactical techniques that both management and innovative staff can employ to guide the creative process. Perhaps the most interesting and revealing of these is Kim and Mauborgne's concept of "value innovation". Studying 30 companies over a period of five years, these researchers attempted to understand what differentiates high-growth companies from their less successful competitors. They observed a wide range of variables and found the only one of significance was management's approach to strategy. Average or unsuccessful competitors followed the conventional strategic logic of attempting to beat the competition while high-growth companies rendered their competition irrelevant by breaking established industry boundaries to create new sources of value for customers while often lowering costs at the same time. They re-shape the industry game. They focus on what the mass of customers have in common rather than the differences between customer segments. This value innovation

approach represents a clear, simple and appealing model for companies to consider. The authors explain that the strategic logic of value innovators differs from conventional logic along five dimensions, as outlined in the table below:

Two Strategic Logics:

Five dimensions of strategy	Conventional Logic	Value Innovation Logic
Industry Assumptions	An industry's conditions are given.	An industry's conditions can be shaped.
Strategic Focus	A company should build competitive advantages.	Competition is not the benchmark. A company should pursue a quantum leap in value to dominate the market.
Customers	A company should retain and expand its customer base through segmentation and customization, focusing on the differences in what customers value.	A value innovator targets the mass of buyers and willingly lets some existing customers go. It focuses on the key commonalities in what customers value.
Assets and Capabilities	A company should leverage its existing assets and capabilities.	A company must not be constrained by what it already has. It must ask, what could we do if we were starting anew?
Product & Service Offerings	An industry's traditional boundaries determine the product and services a company offers. The goal is to maximize the value of those offerings.	A value innovator thinks in terms of the total solution customers seek, even if that takes the company beyond its industry's traditional offerings.

(Kim and Mauborgne, p. 197)

Through the process of value innovation, companies create new solutions that bring unprecedented value to the mass of customers by giving them more of what they want and less of what they can live without. Under the value innovation approach, companies review customer value and ask themselves four main questions:

1) Which of the factors that our industry takes for granted should be eliminated?
2) Which factors should be reduced well below the industry's standard?
3) Which factors should be raised well above the industry's standard?
4) Which factors should be created that the industry has never offered?

These questions should be applied to three platforms on which innovation can take place: product, service and delivery. While many companies focus on only the product dimension, the most successful companies address all three.

By asking these questions, Formula 1, a chain of budget hotels in France, was able to re-define the value of hotel rooms by understanding the most important features for their target travelers – bed quality, hygiene and room quietness. They dramatically outperformed the competition on these dimensions while reducing costs by eliminating less important features – aesthetics, room size and extra furniture in the rooms. Thus, the company's value curve, the graphic depiction of its relative performance across its industry's key success factors, is shaped very differently than those of its competitors. With this value innovation strategy, the company captured the mass of French budget-hotel customers and also expanded the market.

Similarly, Virgin Airlines challenged the established model in the airlines industry by letting the first-class customer segment go in order to focus on the needs of the more profitable business class. Virgin removed first-class seats from its planes and expanded the space available for business travelers, offering them reclining seats. In addition, they established airport lounges where the rushed business traveler could shower, enjoy massages and have clothes pressed and use office equipment before heading to the day's meetings. Virgin violated conventional logic by addressing fewer customer segments and by offering services beyond its traditional capabilities. This approach is why Virgin has always been a successful innovator, (Kim and Mauborgne, p. 216-7).

The implications of the concept of value innovation for education are clear: students should be encouraged to "think outside of the box" and define their own creative solutions to real-life problems, as posed by a problem or project-based learning approach. Business courses that require students to re-define the strategic value curve of a company, product or service could offer a first-hand experience in the value innovation approach. Moreover, value innovation is perhaps a thinking process that could be adapted to a variety of problems, even outside the realm of business.

Peter Drucker's article, "*The Discipline of Innovation*" suggests concepts similar to that of value innovation, just framed from a different perspective. Drucker explains that "most innovations, however, especially the successful ones, result from a conscious, purposeful search for innovation opportunities," (Drucker, p. 145). In other words, management's purposeful search

for new sources of value innovation are fundamental to success. He argues that such opportunities are almost entirely found only within the seven situations described below:

Within a company or industry

1) **Unexpected Occurrences:** Unexpected successes and failures are overlooked by most. For example, the inventor of Novocain intended it to be used for major surgery. However it was preferred by dentists. He spent the remainder of his career lecturing on how his invention was being "misused" and didn't capitalize on the alternate opportunity. Businesses need to be on the lookout for unexpected uses of their products and services.

2) **Incongruities:** Incongruities within the logic or rhythm of a process, between expectations and results or between assumptions and realities can create opportunities for innovation. For example, the steel industry had a growing market size but falling profits. The innovation response was minimills.

3) **Process Needs:** Process improvements can open up new opportunities. For example, the invention of the Linotype made it possible to quickly print large volumes of newspapers, opening up new possibilities for efficiency in mass media.

4) **Industry and Market Changes:** When an industry grows quickly there are often many opportunities to address the new needs of the fastest-growing segments that don't necessarily fit with the way the industry has traditionally done business. Most companies will overlook these new opportunities so innovators will have an advantage.

Outside a company (in its environment)

5) **Demographic changes:** Changes in population, their age distribution, education, occupations and geographic location are among the most rewarding and least risky of entrepreneurial pursuits. For example, the Japanese realized that trends of more people staying in school for higher education meant there would eventually be a labor shortage for blue-collar work. While others recognized the trend, only the Japanese acted on it and attained a ten-year lead in robotics.

6) **Changes in Perception:** Understanding customer perceptions is key to exploiting opportunities. While health and medical care have improved dramatically over recent decades, people are more concerned with health and well-being than ever before. Understanding this perception created new opportunities for health food, supplements and magazines.

7) **New Knowledge:** Knowledge-based innovations are the "superstars of entrepreneurship". When various strands of knowledge converge, innovation arises. The invention of computer represented the coming together of six different strands of knowledge.

Drucker argues that management must purposefully analyze all these sources of new opportunities. In this sense, he suggests that the practice and discipline of innovation can be somewhat systematic, guided by diligence, persistence and purposeful, focused exploration within the seven areas described above, (Drucker, p. 143-59). Careful consideration of Drucker's seven sources of innovation within Kim and Mauborgne's value innovation questions could yield doubly productive outcomes.

The method of exploration and analysis of opportunity areas can further vary depending on management style. Lester, Piore and Malek explain that traditional management methods – termed the *analytical* approach – view the innovation process as an engineering problem that must be directly solved. The manager identifies a clear objective usually based on customer research, identifies the resources needed to meet the goal and assigns discrete components of the problem to the appropriate experts. The authors argue however that this structured approach is no longer appropriate for today's rapidly changing environments which require greater flexibility and where customers aren't always aware of their wants and needs. Instead, they argue that an *interpretive* approach, as used by many R&D departments is more conducive to innovation. Under this method,

> "the manager of the interpretive organization needs to act less like an engineer and more like the leader of a jazz combo. Diverse components need to be brought together – musicians, instruments, solos, themes, tempos, an audience – but their roles and relationships are changing all the time. The goal is not to arrive at a fixed and final shape, but to channel the work in a way that both influences and fulfills the listener's—the customer's—expectations," (Lester et al, p. 166).

Levi's is cited as a company that successfully employs the interpretive approach to develop new products by engaging in an ongoing "conversation" with customers. Designers are encouraged to live the lives of their target customer segments by shopping in their stores, eating at their restaurants, reading their magazines, etc. in order to understand emerging trends. The company both listens and attempts to be an active participant in the "conversation" remaining flexible and continually engaging in the process in an open-ended, experimental manner. Their interpretive approach has led to winning products. The interpretive process is essentially about ongoing communication both with customers and suppliers to uncover solutions under scenarios of uncertainty. The need for interpretive managers has implications for managerial education.

> "Management education is frequently criticized for failing to imbue students with the creativity required for effective leadership and strategic thinking…the current stress on analytical problem solving 'breeds out' the creative dimensions of management….To train interpretive leaders, management teaching would need to be broadened, focusing on developing not only problem-solving skills but also the humanistic skills traditionally associated with the more interpretive fields of literature, history, and anthropology. Management would need to be viewed as much as a liberal art as a science," (Lester, et. al., p. 182-3).

Complementary to the concept of interpretive management, the article, "*Spark Innovation Through Empathic Design*", by Leonard and Rayport, describes the empathic design method to generate discontinuous innovation. The empathic design approach focuses specifically on breakthrough creativity in the workplace. Standard management practice involving customer research and focus groups works well for products that customers are already familiar with and for incremental innovation. However, for breakthrough solutions, where no similar product exists, customers have no foundation upon which to base their opinions. As an alternative, empathic design involves observing customers in their home or work environments to uncover what they may be unaware they need. Through observation, data gathering, reflection, analysis and brainstorming, well-trained observers with deep knowledge of the company's technical capabilities can identify unarticulated needs and solutions to these needs. Exploring the concept of empathic design in greater depth may reveal some important insights: how can we teach students to be astute observers and to devise solutions to unarticulated problems?

What Contributes to the Development of Successful Entrepreneurs?

Not surprisingly, many of the characteristics of successful entrepreneurs echo those of the successfully creative individual. Since the 1950s, many studies have attempted to analyze these characteristics. Contrary to the popular myth of the entrepreneur as a superstar, Hatch and Zweig explain that many tend to embody the concepts of 'average' and 'unexceptional'. Of the entrepreneurs they studied, few were academic standouts or excelled in sports or some other activity. Most came from middle or upper class backgrounds. "The evidence showed that the founders of rapidly growing firms were actually average and sometimes mediocre performers in other aspects of their lives," (Hatch & Zweig, p. 68-9). Moreover, their paths toward entrepreneurship differed: some did and some didn't have post-secondary degrees. Some began engaging in entrepreneurial activity very young, and some later in life. Thus, defining just what sets the successful entrepreneur apart from the rest of the population cannot be attributed to their experience. While entrepreneurs' backgrounds are unexceptional and their paths diverse, what unites them is the entrepreneurial spirit. In 1994, Timmons analyzed more than 50 studies of the characteristics of entrepreneurs and found a consensus around the following general characteristics of that embody this spirit: 1) commitment and determination, 2) leadership, 3) opportunity obsession, 4) tolerance of risk, ambiguity and uncertainty, 5) creativity, self-reliance and ability to adapt, and 6) motivation to excel, (Byers, et al, p. 2). In addition, data indicates that entrepreneurs show a high tolerance for risk, a desire for control and autonomy (exemplified in wanting to work for themselves), as well as strong personal ambition, perseverance and decisiveness. In the decisiveness dimension, entrepreneurs differ from others in that

> "many of their decisions are made alone or with modest amounts of advice, must be made quickly, and can have a significant impact on the company. These entrepreneurs must also be able to make mid-course corrections. The alacrity and flexibility displayed in making these decisions – in changing them if necessary—are what distinguishes the entrepreneur. Contrast this with the typical process in a large corporation, where time consuming, extensive analysis precedes each decision, and feedback is slow in coming," (Hatch & Zweig, p. 71).

Closely related to decisiveness, entrepreneurs also demonstrate a readiness to act. They turn decisions into actions. They demonstrate a preference for learning through trial and

experimentation rather than reflection and theory, which has clear implications for project-based learning and any other such action oriented programs.

In addition to the entrepreneurial spirit, the generation of the business ideas is important. Idea generation involves insight – the ability to perceive an opportunity where others may not. This is potentially a skill developed by creative-problem solving "problem finding" techniques, as well as consideration of Kim and Mauborgne's value innovation questions and Drucker's seven sources of innovation, as described in the previous sections. Facilitating idea generation, low levels of associative barriers may also enhance entrepreneurial abilities. Thorough exposure to two or more cultures helps people break down barriers. Such persons "seem to have an advantage in the range of hypotheses they are apt to consider, and through this means, in the frequency of creative innovation". These individuals are not wedded to one point of view and are generally aware that there are multiple ways of looking at something. Thus, they can approach a situation from a variety of perspectives.

Paul Maeder, founder of Highland Capital, a venture capital company, works with numerous entrepreneurs and sees the traditional education system as potentially limiting the creativity involved in entrepreneurship by fostering false associative barriers and entrenching people in singular perspectives. Maeder has noted that many innovators seem to be self-taught, and sites examples of innovators who were not formally trained. Thomas Edison, Charles Darwin and Steve Jobs all had little higher education but were avid readers and self-educators.

> "Through school, mentors and organizational cultures, education tends to focus on what a particular field has seen as valid. If, for instance, you wish to be a great medical doctor, there are rules that must be mastered. A good education will teach you these rules. You learn what past experts and thinkers concluded and use their experiences to build your own expertise….The price for such an approach, however, is that one more easily becomes wedded to a particular way of doing things. As a result, associative barriers are erected, making intersectional ideas less likely….Instead, we must employ tactics that allow us to *learn as many things as possible without getting stuck in a particular way of thinking about those things."* (Johansson p. 50).

By learning fields on our own, we have a greater chance of approaching them differently. The correlation between formal education and one's success as a creator looks like an inverted U. "That is, formal education first increases the probability of attaining creative success, but after an optimum point it actually lowers the odds. This point occurs a bit earlier for artistic careers and

a bit later for scientific paths…All of this suggests that it makes sense to spend significant amounts of time reading and drawing, learning and experimenting, without guidance from instructors, peers, and experts," (Johansson, p. 52-53). Thus, there is a complex relationship between expertise in a domain and an entrepreneur's capacity to think beyond that domain's traditional paradigm.

What about education in entrepreneurship itself? When it comes to developing entrepreneurial capability, much of the literature agrees that the topic is not easily taught in a classroom setting. Entrepreneurship is best carried out by individuals for whom the set of personal characteristics mentioned above comes naturally. Thus, not everyone is well suited for the job and so entrepreneurship education and training should tread carefully. "It would be wrong to delude kids into believing that the calling was easy or for everyone," (Southon and West, p. 1). Nonetheless, there is still a place for entrepreneurship courses. Teaching entrepreneurship at the K-12 level can build awareness and help potential entrepreneurs discover their calling and hone their abilities. And, for those not interested in entrepreneurship, discovering it's not for them is also useful. Additionally, regardless of their entrepreneurial proclivity, all students could benefit from complimentary skills training such as basic financial accounting, selling, and history of the rise and fall of businesses and of the life experiences, both of highly successful entrepreneurs and more moderately successful ones.

Although it is frequently argued that the most essential entrepreneurial capabilities are personality traits that cannot easily be taught in a classroom, entrepreneurship training courses have nonetheless flourished in recent decades, perhaps for the reasons above. Some form of entrepreneurial classes have sprung up more than 1,500 US colleges growing rapidly throughout the 1990s (Baily, p. 1). Courses are being offered both in business schools and in other disciplines, such as engineering and the arts, both at the graduate and undergraduate level. In their study "Impact of Entrepreneurship Education," Alberta Charney and Gary Libecap concluded that entrepreneurship education helps produce self-sufficient enterprising individuals, successful business leaders and champions of innovation. Their findings were based on a comparison of University of Arizona Berger Entrepreneurship Program graduates to other University of Arizona Business School Graduates (Kauffman Center, p.2). Additionally, there is indication of a link between these entrepreneurship programs and an increased number of start-

ups launched by students either during or closely following school (Kauffman Center, p. 7-8). While the causal link is not clear, the Kauffman center explains,

> "Research indicates entrepreneurship program graduates are three times more likely to be involved in the creation of a new business venture than their nonentrepreneurship business counterparts. Further, Alberta Chaney and Gary D. Libecap found that graduates of the University of Arizona's Berger Entrepreneurship Program were 11 percent more likely than were non-entrepreneurship students to own their own businesses after graduation," (Kauffman Center, p. 8).

In terms of teaching and curriculum design, many entrepreneurial programs employ innovative methods. Experiential learning is central to most entrepreneurship training courses at the university level. Real world projects, internships, case studies and business plan competitions are key elements. At Babson college, for example, the Freshman Management Experience allows students to plan, launch, manage and liquidate a for-profit venture. The University of Maryland houses undergraduate business students in an eDorm, an incubator like facility from which they can start and run their businesses, (Kauffman Center, p. 9).

Beyond pedagogy, mentoring and networking have also been identified as extremely important for aspiring entrepreneurs (De Faoite, et al, p. 433). The involvement of entrepreneurs either in the classroom or as mentors and judges of business plan competitions is a key element of many entrepreneurship programs. As such, many programs are run or assisted by former or current entrepreneurs who play a role as adjunct or non-tenured faculty. While such individuals are crucial to maintaining a practical, hands-on perspective in the classroom, the Kauffman Center suggests that their roles need to be complemented by increased opportunities for tenured entrepreneurship faculty who will focus on research to advance the intellectual underpinnings of the field, which are currently still in infancy. These faculty "must be supported, mentored and encouraged." (Kauffman Center, p. 19).

While many business schools teach entrepreneurship, there is a view that the methods need an overhaul. David Birch, an entrepreneurial expert believes that entrepreneurship would be best taught not through the classroom, but through apprenticeship. Intuitively, an experiential approach seems most appropriate for entrepreneurship training. One study of traditional lecture-tutorial entrepreneurship training in Singapore argues for this point exactly, sighting evidence of success through a problem-based curriculum. See Lynda Wee's article, "*A Problem-Based*

Learning Approach in Entrepreneurship Education: Promoting Authentic Entrepreneurial Learning". David Birch also explains that if courses are to be taught in entrepreneurship, they need traditional courses in sales and product development but also need to understand how to work with people and influence them which is perhaps a less well-recognized need. Birch explains,

> "For entrepreneurs to succeed they have to create a needed product or service, sell it, and work with people. So, a change in curriculum is needed. The first course is sales—how do you make sales? The second course is on how to lead people and to get people to go with you to do something. The third should be how to create a product or service that people or companies need. If any curriculum is going to be relevant for entrepreneurs-to-be, it has to have these courses," (Aronsson, p. 2).

Byers expands on Aronsson's concept, stressing the importance of the social aspects of entrepreneurship: While much of the discussion of entrepreneurs and entrepreneurship focuses on the individual, Byers asserts that this emphasis a "fundamental attribution error". Observers place too much credit with personality and individual characteristics and can't see factors outside the person that "drove him or her to action". Instead, they suggest that entrepreneurship should be more accurately viewed as a social activity. They explain:

> "Building a company entails hiring, organizing, and inspiring a collection of people who typically need to get start-up funds from others, to buy things from other people, and, ultimately, flourish or fail together as a result of the ability to sell things to yet another group of people. The emphasis on rugged individualism is so prevalent in western culture that many of the lists of "characteristics of successful entrepreneurs" barely reflect that launching a start-up entails constant interaction with others," (Byers, et al, p. 4).

As such, they explain that entrepreneurship is embedded in a social context and is facilitated by a person's social network. They conclude that the study and teaching of entrepreneurship should include a greater focus on social behavior – on how to identify and maintain relationships that will be crucial to success and to build the skills related to interpersonal influence, persuasion and negotiation (Byers, et al, p. 5-7).

Despite an increased proliferation of entrepreneurship programs, research and multiple viewpoints on the topic, there is still no set curriculum prescribed for the subject and there appears to be little in the way of evaluation of current effectiveness of these programs in terms of their contribution to the emergence of successful entrepreneurs. Such evaluation would need to

be undertaken before more specific recommendations regarding just what contributes to entrepreneurial development.

A starting point for further research could be with the Consortium for Entrepreneurship Education (http://www.entre-ed.org). This Consortium serves as a clearinghouse and information center for the topic of entrepreneurship education. Their website includes access to information resources, teaching materials, networks and membership details. Their resources focus on life long learning with content aimed at elementary through university-level and professional training. In addition, the Consortium provides a "Toolkit for National Content Standards for Entrepreneurship Education". This model aims to serve as a framework for developing entrepreneurship curricula at all levels. They offer fifteen major standards, divided into the following three categories:

- **Entrepreneurial Skills**
  The unique traits, behaviors and processes that differentiate an entrepreneur from an employee or manager.
- **Ready Skills**
  The business, or entrepreneurial, knowledge and skills that are prerequisites or co-requisites for the study of entrepreneurship.
- **Business Functions**
  The business activities performed in starting and running a business.

A deeper review of the pedagogy and educational standards that this Consortium promotes may provide insight into the most popular and/or effective methods and techniques of teaching and learning entrepreneurship.

What is the Nature of our Culture, Society and Economy that Makes our Country Creative and Innovative?

It is commonly suggested that American culture, society, economic and legal institutions are specifically conducive to entrepreneurship and innovation. The confluence of these elements has tangible impacts: more than 500,000 firms are started in the US every year. In 2003, 11 out of every 100 adults were engaged in entrepreneurial activity – a rate higher than anywhere in Europe, (Schramm, p. 2). The US not only has a high rate of entrepreneurship, but also high-rate of "high-impact firms"— the kind that create value and stimulate growth by bringing new ideas to market.

What are the roots of this American exceptionalism? First of all, the US has created a relatively favorable context for fostering innovation: Elements of this context include political stability, appropriate business policies, laws and regulations, legal protection of property rights and easy access to financial and human capital. However, this is not the end of the story. Carl Schramm, President and CEO of the Kaufman Foundation, explains, "Firms do not appear automatically, as a natural by-product of having free-market institutions. Not are they the result of any single factor. Rather, the United States has evolved a multifaceted "system" for nurturing high-impact entrepreneurship," (Schramm, p. 1). Schramm's system involves four sectors of the economy: high-impact entrepreneurs, large mature firms, the government, and universities. New, entrepreneurial companies in the US can benefit from symbiotic relationships with large, mature firms who are often their customers while large firms effectively outsource R&D to small companies, allowing them to assume the risk and then making an acquisition once value has been created. The government's role includes funding research and investing directly in innovation in certain areas such as defense technology and space exploration. At the same time, universities generate a constant flow of research and ideas. "The resulting economic growth has been tremendous. It has been estimated that the companies spun out from just one university, the Massachusetts Institute of Technology (MIT), would constitute a nation with the twenty-fourth largest GDP in the world," (Schramm, p. 1-4).

When it comes to the role of culture, there is debate surrounding its importance. Areas of culture that are typically linked with innovation and entrepreneurship are individualism, uncertainty-

avoidance, risk-taking and masculinity. The United States is generally characterized as highly individualistic and non-conformist, driven by a profit motive. Contrasting the cultural attitude towards entrepreneurship in the US and Sweden, David Birch, an entrepreneurship research explains, "If you say, 'I am thinking of starting my own business,' the responses in Sweden and the United States are very different. It is a deeply cultural difference," (Aronsson, p. 291). While some, like Birch, assert that it is a key driver of innovation, others cite counter examples such as China. Although it has a very collectivist culture, China has recently shown strong innovative capabilities, defying the theory that an individualist culture is crucial to entrepreneurship. The example thus indicates that structural, institutional and economic factors may be more powerful variables in entrepreneurship than is culture. Hayton, et al. provide a balanced view of the culture-innovation link with culture as "a moderator of the relationship between contextual factors and entrepreneurial outcomes," thus acting as a catalyst rather than a causal agent of entrepreneurship, (Hayton, et al; p. 45). For a useful model for the interaction between institutional economic and cultural factors, as well as cognition and motives in the spurring of entrepreneurship, see Hayton et al, page 46.

Sternberg's article, "*Societal and School Influences on Student Creativity: the Case of China*" provides further insight. The article describes experiments comparing the creativity of Chinese and American students. Students were instructed to create a collage and to draw a picture of an alien. Judges rated the American products as significantly more creative. While the study's sample size and method may leave room for questions, it does conclude that there is at least a preliminary indication that the cultural, educational and social contexts of China and the US play a role in student creativity. Chinese culture is less supportive of individual autonomy and the Chinese pedagogical system emphasizes analytical skills over self-expression to a greater extent than the does the U.S. system. Finally, the importance of standardized tests plays a more vital role in determining a student's educational destiny and career in China than in the US. Also important to note, when Chinese subjects were instructed to be more creative and were provided with guidance on how to be creative, their judged ratings on creativity increased. This suggests that simply teaching and encouraging creativity among students is one way to enhance creative outcomes and that social environments should aim to protect individual autonomy. This idea may be related to why we see greater innovation in China today than in the past, despite the

supposed cultural barriers. In other words, cultural barriers may be easily overcome when economics and institutions favor change.

One potential role for culture can be seen as an extension of Sternberg and Lubart's "investment theory of creativity" which likens creative people to good investors--they buy low and sell high in the world of ideas. They come up with ideas that are unpopular (buying low); seek to convince others of the value of these ideas; and then move on to their next unpopular idea (selling high). Thus, they defy the crowd, generating and attempting to convince people of the value of ideas otherwise ignored or rejected. The theory argues that good investors in the world of ideas need a confluence of six resources in order to buy low and sell high: intelligence, knowledge, thinking styles, personality, motivation, and environment. One reason it is so difficult to buy low and sell high (whether in financial investing or in the world of ideas) is that it is difficult to get an adequate confluence of these resources, so that they work together. Nonetheless, Sternberg does feel that the individual can, at least to some extent, influence these variables and control his/her ability to be a successful creator. In this vein, the book also provides a series of correlational studies, cases and guidelines to support the theory and illustrate how creativity can be enhanced, such as through redefining problems, looking for what others do not see, persevere in the face of obstacles and leveraging one's intrinsic motivation.

We can infer from this idea that if creators must be able to sell high, there must be some element of receptivity in the culture/society – some openness to different ideas and willingness to absorb change. It could be argued that because of its diversity, its newness and the roots of its dominant culture in Protestantism, the United States possesses a greater proclivity towards this receptivity to change and new ideas than perhaps other cultures, rooted in more firm traditions. Additionally, because of the United States strong economy and financial infrastructure, political stability and easy access to capital, it may be inferred that the context of buying low and selling high is less encumbered by structural or environmental barriers in the United States than in other countries.

Recommendations for Education

1. **Design educational curricula that promote all three components of "successful intelligence":** As Sternberg explains, today's educational model generally supports the development of one kind of analytical thinking. This needs to be balanced with a focus on the synthetic, analytical and practical aspects of successful intelligence, especially as the combination of the three results in creativity. The use of divergent thinking exercises, open-ended challenges such as those posed by PBL programs and the thinking tools proposed by organizations such as the Center for Creative Learning can all play a role in the development of the creative aspects of successful intelligence.

2. **Promote the Decision to Be Creative and a Meta-Cognition of the Creative Process:** Following Sternberg's suggestion that the one consistent attribute among successfully creative people is there explicit decision to pursue a creative path, educational programs should not only aim to enhance student creativity, but should also directly teach students about the field of creativity itself so that they gain an explicit awareness of their own creative potential, as well as and understanding of methods of enhancement. With this knowledge, they can both make an informed decision to pursue creative activities and at the same time, better control and direct the development of their abilities. This meta-cognition of the creative process should also involve explicit awareness of the practical skills involved in creativity such as the processes of managing one's emotions, one's ability to persevere in the face of challenge, the marshaling of cognitive resources, learning one's strengths and weaknesses and managing time allocating to creative pursuits. These are skills that can and should be explicitly discussed in the classroom.

3. **Foster classroom environments and pedagogical approaches conducive to intrinsic motivation:** Help students find their passion and shield them from the potentially damaging impacts of rewards, extrinsic motivators and experiences of failure. The effort to help students develop passion should also involve the promotion of confidence, persistence and risk taking. Where appropriate, allow students to

define their own problems and conduct a self-assessment of their efforts and outcomes, rather than always having work both defined and evaluated by teachers. It is too often that students curiosity, motivation and creativity are stifled by the educational environment. A deeper understanding of how and why this happens and how to correct for it are needed. Recommendations from the Educational Programs section of this paper should be considered, such as making grades informational rather than controlling, allowing students room to choose their own projects.

4. **Increase the usage of problem and project based learning in the classroom:** Executed correctly, PBL programs have shown significant promise to increase a broad range of thinking abilities, including creative thinking and help link education to relevant, ill-defined, real-life experience. This connection is crucial for engaging students and increasing motivation, as well as helping develop the thinking skills crucial to "successful intelligence" as defined by Sternberg. A deeper review of some of the more well-regarded PBL programs as well as the principles of effective PBL and their impacts on creativity will be key to understanding how to best implement this recommendation. The more closely linked these projects are to students real lives and environments the more meaningful they become.

5. **Re-align the high-stakes testing system to reflect the need for focus on creativity:** Strike the right balance between ensuring that classrooms focus on basic skills, but that teachers still have time and autonomy for a broad range of activities so that the testing of these skills does not crowd out creative pursuits. At the same time, if what gets tested is what gets taught, ensure that schools are as accountable for creativity as they are for performance in basic skills. While a wide range of tests for creative thinking exist, the most appropriate method of assessing creativity is to review creative outputs themselves. Portfolios, demonstrations and exhibitions of student work are suitable methods of ensuring that creative projects are incorporated into teaching and learning.

6. **Promote the integration of entrepreneurship courses into the K-12 curriculum:** These courses are probably most appropriate at the junior high and high school level and should be project-based or otherwise action-oriented and experiential. One aim of such courses should be to help students discover whether entrepreneurialism is right for them.

7. **Further integrate games and play into education:** As discussed by Daniel Pink, play has a central role in the creative process. In addition, the enjoyment factor involved in games has potential to greatly enhance motivation and interest among students, thereby opening doors for flow and creativity.

8. **Increase the use of interdisciplinary learning:** Lessons that span multiple subject areas will familiarize students with the concepts of linking otherwise separate concepts or disciplines to discover new ideas at the intersection of fields. Especially in the upper grades, having students work in teams where diverse talents, interests and thinking styles are represented will offer practice in the group dynamics that lead to organizational innovation.

9. **Improve career counseling and opportunities for career exploration:** The greatest potential for creative success will lie among students who find their passion and dive into it early in life. Potential implications of this viewpoint are that the educational system should provide greater focus on helping students identify areas of interest – areas where they can achieve the a state of flow which leads to growth of skill and confidence, the states under which creativity blossoms. As a corollary, the educational system should help students strike the right balance of depth and breadth of knowledge (the T-shaped mind). There is a concern that many liberal arts students are graduating from universities as generalists and have missed early opportunities to discover an area of passion or interest in which to build deeper knowledge.

Suggestions for Further Research

1. **Conduct more research into the programs and methods of instruction that can be used to promote creativity:** This paper has identified numerous tools, techniques, strategies and programs of study that have been designed to enhance creativity. However, the effectiveness of each of these programs often needs more substantiation. Where assessment of a program's impact has been done, its usually in isolation from other alternative programs and so comparisons between them are few. Delving deeper into the more promising of these is a necessary next step. Particularly the project-based learning and CPS examples show promise, but nonetheless require further assessment.

2. **Identify and Understand Barriers to Entry** – While the US has been traditionally relatively more innovate than other regions, what will enable the country to maintain this edge going forward? As other regions develop greater financial infrastructure's to support risk-taking ventures and continue to provide a range of services at lower cost, how can the US retain an edge? A Harvard Business Review article, "*The Rise of Innovation in Asia*" provides an example of a growing and recognized trend:

   > "John Deng, CEO and president of Chinese chipmaker Vimicro, said his company is proof of Chinese innovation. Vimicro holds some 400 patents and is the world's leading supplier of PC camera processor chips. "We have moved from 'manufactured in China' to 'designed in China,'" he said….Certainly the United States has no lock on innovation….Technology is the great leveler, the powerful ingredient that can catapult a company, an industry, and even a country to the head of the class almost overnight."
   > (HBS, http://hbswk.hbs.edu/item.jhtml?id=4676&t=globalization&iss=y, p. 1)

3. **Contact the following individuals and organizations:**

- **Erica Clark at the Art Center College of Design**. A visit to the school in Pasadena could prove enlightening. Their joint program with INSEAD Business School, their international programs and their integration of design with a range of fields are exemplary of how creativity can be incorporated into across disciplines.

- **Don Treffinger at the Center for Creative Learning (CCL)**. Attending their July teacher workshop and getting Don's perspective on creativity would be valuable. CCL offers a variety of publications, training programs, information support, and consulting services on creativity, Creative Problem Solving, talent development, and learning styles. See http://www.creativelearning.com/ for more. Also, http://www.creativelearning.com/OtherSites.htm provides links to websites focused on creative development and methods to stimulate creativity. Several books on creative problem solving available on their site.

- **Destination Imagination**: Consider which aspects of this program could be integrated into classroom practice. See http://destinationimagination.org/learn/whatwedo.hitm.

- **Future Problem Solving**: Consider which aspects of this program could be integrated into classroom practice. See http://www.fpsp.org

- **The Charter High School for Architecture and Design** – As discussed in Daniel Pink's **A Whole New Mind,** this tuition-free Philadelphia public school founded offers a design centered curriculum, marrying design to Math, Science, English and Social Studies.

- **The Entertainment Technology Center at Carnegie Mellon University -** This collaboration between Carnegie Mellon's College of Fine Arts and School of Computer Science offers a masters in entertainment technology and is a clear example of cross-disciplinary creative skill development as well as the role of play in creativity.

- **Nina L. Greenwald, Faculty, Graduate Program of Critical and Creative Thinking University of Massachusetts Boston**: Nina Greenwald is a national teacher trainer, workshop leader and keynote speaker. Her publications include articles on teaching creative thinking and problem solving, cultural impediments to creative development and problem-based learning (PBL). She has authored "thinkingbased" curricula for NIH, AMA, National Societies for Biomedical Research, The New England Aquarium, and NOVA. Her book Science in Progress has been adopted by the Pennsylvania State Department of Education. Currently, she is collaborating on a book focused on concept-

based teaching of college level science. In addition, the Graduate Program in Critical and Creative Thinking at the University of Massachusetts, Boston may offer some interesting insights into pedagogical methods that enhance creativity. In May 2005, An attempt was made to contact Greenwald and understand more, however she was not available at the time.

- **American Creativity Association (ACA)** http://www.amcreativityassoc.org/ – For more than a decade, the American Creativity Association has been a primary resource for learning and applying creativity, innovation, problem-solving, and ideation theory, tools, and techniques. ACA offers a global network of creative professionals in disciplines ranging from business and industry to education and the arts. ACA provides a wide range of problem-solving methods, from simple idea-capture techniques to complex problem-solving methodologies. ACA's 2005 Conference: March 30-April 2 called "Feel the Fire" concerning the connection between passion, energy and creativity.

- **The Creative Education Foundation**:
  http://www.creativeeducationfoundation.org/
  The Creative Education Foundation is a non-profit membership organization of leaders in the field of creativity theory and practice. It's mission is to serve as the center for applied imagination. Provides educational tools and materials to help creative thinking. Publisher of the Journal of Creative Behavior and organizer of the annual Creative Problem Solving Institute Conference. In 2005, this conference will be held in St. Paul, Minnesota, June 26-July 1 with keynote speaker Richard Florida.

- **The Creative Problem Solving Group**: http://www.cpsb.com/
  CPS-B is an international center for applied research and development, promoting learning through organizational partnerships. CPS-B has been asked by clients to assist in areas such as New Product/Service Development, Building Creative Teams, Leadership Development, CPS Training & Facilitation, Organization and Team Climate Assessment & Development, Creativity & Innovation Consulting as well as keynote speeches on topics like Creativity, Innovation, Leadership & Organizational Climate.

- **International Center for Studies in Creativity**:
  http://www.buffalostate.edu/centers/creativity/Resources/CSL.html
  A department of Buffalo State College in New York, ICSC Offers workshops, undergraduate and graduate programs in creativity studies. The center also houses an extensive reference library of creativity literature known as the Creative Studies Library. The website includes faculty profiles and links to numerous creativity resources plus a "Creativity-based Information Resources" database.

References

1. Agrey, Loren "The Pressure Cooker in Education: Standardized Assessment and High-Stakes" in *Canadian Social Studies*; Vol. 38, No. 3, Spring 2004

2. Amabile, Teresa M.; "How to Kill Creativity" in *Harvard Business Review*; Sept-Oct 1998.

3. Amabile, Teresa M.; Growing Up Creative; Creative Education Foundation; 1992

4. Aronsson, Magnus; "Education Matters—But Does Entrepreneurship Education? An interview with David Birch" in *Academy of Management Learning and Education;* Vol. 3 No. 3; 2004.

5. Baily, Jeff; "Small Business -- Enterprise: Entrepreneurship: Can the Touch Be Taught?; Maybe Not, Say Sponsors, But New College Programs Can Provide Useful Skills" in *The Wall St. Journal*; (Eastern edition). New York, Aug 5, 2003

6. Byers, Tom, Heleen Krist and Robert I. Sutton; "Characteristics of the Social Entrepreneur: Social Creatures, Not Solo Heros" in Richard C. Dorf (Ed.), **The Handbook of Technology Management**; CRC Press LLC, Boca Raton, FL; 1997
http://www.stanford.edu/class/e140/e140a/content/Characteristics.html

7. Cropley, Arthur J.; **Creativity in Education and Learning: A Guide for Teachers and Educators**; Kogan Page; London, 2001

8. De Faoite, Diarmuid, Colette Henry, Kate Johnston, and Peter van de Sijde; "Education and Training for Entrepreneurs: A consideration of initiatives in Ireland and the Netherlands" in *Education & Training;* Vol 45 No. 8/9, 2003

9. Drucker, Peter; "The Discipline of Innovation" in **Harvard Business Review on Breakthrough Thinking**; Harvard Business School Press; USA, 1999

10. Durtschi, Cindy; "The Tallahassee Bean Counters: A Problem-Based Learning Case in Forensic Auditing" in *Issues in Accounting Education*; Vol. 18, No. 2; May 2003

11. French, Dan "A New Vision of Authentic Assessment to Overcome the Flaws in High Stakes Testing" in *Middle School Journal*; National Middle School Association; Vol 35, No. 1; Sept 2003

12. Gardner, Howard; **Creating Minds: An Anatomy of Creativity Seen Through the Lives of Freud, Einstein, Picasso, Stravinsky, Eliot, Graham, and Gandhi**; Basic Books; Reprint edition; 1994

13. Gardner, Howard and Emma Policastro; "**From Case Studies to Robust Generalizations: An Approach to the Study of Creativity**" in *Handbook of Creativity*; Robert J Sternberg, ed.; Cambridge University Press; 1999

14. Greenwald, Nina; Allyn Bradford, Arthur Millman and Peter Taylor; **Thinking for Change: A Resource Center for Critical and Creative Thinking and Reflective Practice**;
http://www.cct.umb.edu/tfcfb.pdf

15. Hargadon, Andrew and Robert I. Sutton; "Building an Innovation Factory", *Harvard Business Review*, May-June 2000; available on
http://www.leadershipadvantage.com/creatingClimateForInnovation.shtml

16. Hatch, Jim and Jeffery Zweig; "What is the Stuff of an Entrepreneur" in *Ivey Business Journal*; Nov/Dec 2000

17. Ings, Welby; "Re-think"; International Technology Education Association (ITEA
http://www.iteaconnect.org/editorpage/2005/April/rethink.pdf

18. Johansson, Frans; **The Medici Effect: Breakthrough Insights at the Intersection of Ideas, Concepts, and Cultures**; Harvard Business School Press; 2004

19. Leonard, Dorothy and Jeffery F. Rayport; "Spark Innovation through Empathic Design" in **Harvard Business Review on Breakthrough Thinking**; Harvard Business School Press; USA, 1999

20. Leonard, Dorothy and Susaan Straus; "Putting Your Company's Whole Brain to Work"; in **Harvard Business Review on Breakthrough Thinking**; Harvard Business School Press; USA, 1999

21. Lester, Richard, Michael J. Piore and Kamal M. Malek; "Interpretive Management: What General Managers Can Learn from Design" in **Harvard Business Review on Breakthrough Thinking**; Harvard Business School Press; USA, 1999

22. Lipwell, Shee; "Creativity and Medical Education" in *Medical Education*, vol. 36 Blackwell Science Ltd; 2002

23. Kim, Chan and Renée A. Mauborgne; "Value Innovation: The Strategic Logic of High Growth"; in **Harvard Business Review on Breakthrough Thinking**; Harvard Business School Press; USA, 1999

24. Kauffman Center, the "The Growth and Advancement of Entrepreneurship in Higher Education" *Futures 21*, Prepared by the Kauffman Center for Entrepreneurial Leadership Staff; Winter 2001

25. Mauzy, Jeff and Richard A. Harriman; **Creativity Inc.: Building an Inventive Organization;** Harvard Business School Press, 2003

26. Muzslay, Leigh "Beyond A-B-C: What Testing Doesn't Measure" Special Report in *The Sun and Inland Valley Daily Bulletin*; Oct 3, 2004.
http://lang.sbsun.com/socal/beyondabc/part_5/future_main.asp

27. Mierson, Sheela & Kevin Freiert; "Problem-Based Learning". ASTD; October 2004

28. Nakamura, Jeanne and Mihaly Csikszentmihalyi, "The Motivational Sources of Creativity as Viewed from the Paradigm of Positive Psychology" in Aspinwall, Lisa G. and Ursula M. Staudinger's **A Psychology of Human Strengths : Fundamental Questions and Future Directions for a Positive Psychology**; American Psychology Association, November 2002

29. Nickerson, R.S.; "Enhancing Creativity"; in Robert J. Sternberg's **Handbook of Creativity**; Cambridge University Press; 1998

30. Johansson, Frans; **The Medici Effect: Breakthrough Insights at the Intersection of Ideas, Concepts, and Cultures**; Harvard Business School Press; 2004

31. Piirto, Jane; **Understanding Creativity**; Great Potential Press; 2004

32. Pink, Daniel; **A Whole New Mind: Moving From the Information Age to the Conceptual Age**; Riverhead Hardcover, March 2005

33. Scott, Ginamarie, Lyle Leritz and Michael Mumford; "The Effectiveness of Creativity Training: A Quantitative Review" in Creativity Research Journal; Lawrence Erlbaum Associates; 2004

34. Simonton, D.K., "Creativity: Cognitive, Developmental, Personal and Social Aspects", in American Psychologist; January 2000, p. 151-8.

35. Simonton, D.K., "Creativity as Blind Variation and Selective Retention: Is the Creative Process Darwinian?" in *Psychology Inquiry*; Vol. 10, No. 4; Lawrence Erlbaum Associates; 1999

36. Simonton, D.K.; "Scientific Creativity as Constrained Stochastic Behavior: The Integration of Product, Person and Process Perspectives"; in *Psychological Bulletin*; Vol. 129 No. 4; 2003

37. Schooler, Jonathan W.; Fiore, Stephen M.; "Stirring Things Up" (Book Review of Gardner's Creating Minds: An Anatomy of Creativity Seen Through the Lives of Freud, Einstein, Picasso, Stravinsky, Eliot, Graham, and Gandhi); Applied Cognitive Psychology, Vol. 9 Issue 6, Dec 1995

38. Schramm, Carl J.; "Building Entrepreneurial Economies" in *Foreign Affairs*; July/August 2004

39. Southon, Mike and Chris West; "Capitalism for Kids: Teaching entrepreneurial skills in our schools"; in *Director*; September 2004

40. Sternberg, Robert J. **Successful Intelligence**; Plume Books; Oct, 1997

41. Sternberg, Robert J. and Linda A O'Hara, "Creativity and Intelligence" in Handbook of Creativity; Edited by Sternberg; Cambridge University Press; 1998

42. Sternberg, Robert J., "Creativity as a Decision" in A. L. Costa (Ed.), **Teaching for Intelligence II**; Skylight Training and Publishing Inc.; Arlington Heights, IL, 2000

43. Sternberg, Robert J. "Creative Thinking in the Classroom", in *Scandinavian Journal of Educational Research*; Vol. 47, No. 3; 2003

44. Sternberg, Robert J. and Weihua Niu "Societal and School Influences on Student Creativity: the Case of China" in *Psychology in the Schoools*; Vol. 40, No. 1, 2003

45. Tan Oon Seng; "Thinking Skills, Creativity, and Problem-Based Learning"; Temasek Polytechnic Singapore; http://pbl.tp.edu.sg/Others/Articles%20on%20Others/TanOonSeng.doc

46. Wee, Lynda, "A Problem-Based Learning Approach in Entrepreneurship Education: Promoting Authentic Entrepreneurial Learning" in *The International Journal of Technology Management*, 2004